



NASA SPECIAL PUBLICATIONS

A Selective Catalog

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Introduction

NASA Special Publications report advances in science, engineering, technology, and management in the course of the exploration of space. These publications contain new information and data regarding the Earth, the Moon, other planets, and interstellar phenomena; histories of significant programs, experiments, and flights; descriptions of many devices, concepts, and systems; and proceedings of conferences and symposia of specialists in numerous disciplines.

Many of the discoveries and innovations of NASA research centers, contractors, and subcontractors are being used now in medical, educational, and other research. Handbooks, bibliographies, and guides prepared for aerospace workers also serve scientists and engineers in other fields. The Technology Utilization Series (pp. 22 to 34) especially emphasizes findings, data, and ideas likely to be helpful to industry.

This catalog lists the most recent NASA Special Publications and others in which time has not diminished interest. All NASA Special Publications have been announced in the semimonthly abstract journal STAR (Scientific and Technical Aerospace Reports), which is a major element in the NASA scientific and technical information system. All of the publications listed in this catalog were issued before January 1971.

To order one of these publications, please identify it by its title and the "NASA SP" number assigned to it.

The initials "GPO" preceding the price of a publication indicate that it may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

The initials NTIS preceding the price of a publication indicate that it may be purchased from the National Technical Information Service, Springfield, Va. 22151.

Contents

General Series.....	1
Technology Utilization Series.....	22
Histories and Chronologies.....	35
Management, Evaluation, and Analysis Standards.....	37
Handbooks, Data Compilations, Charts, and Tables.....	39
Other Reference Works.....	43
Subject Index.....	45

For sale by the Superintendent of Documents,
U.S. Government Printing Office, Washington, D.C. 20402
Price 30 cents.

This Island Earth

Edited by Oran W. Nicks

We do not realize what we have on Earth until we leave it.

—JAMES M. LOVELL

Illustrated with scores of large color photographs taken by the Apollo astronauts, this is an account of how our planet would appear to visitors from afar and suggests the ways in which further exploration of the solar system may enhance our appreciation and enjoyment of our home planet.

"Although many of the photographs have scientific significance," the editor explains, "the book was written to share with all men a sobering realization of man's place in the universe."

Chapter titles indicate its scope:

Near a Star Called Sun: The Earth/Moon "double planet" stands out among the spheres circling our Sun.

The Restless Atmosphere: Its moods affect us all. New techniques have begun to help us read the clouds.

The Waters of Earth: All life began in them. Yet the seas are still our planet's least-tapped resource.

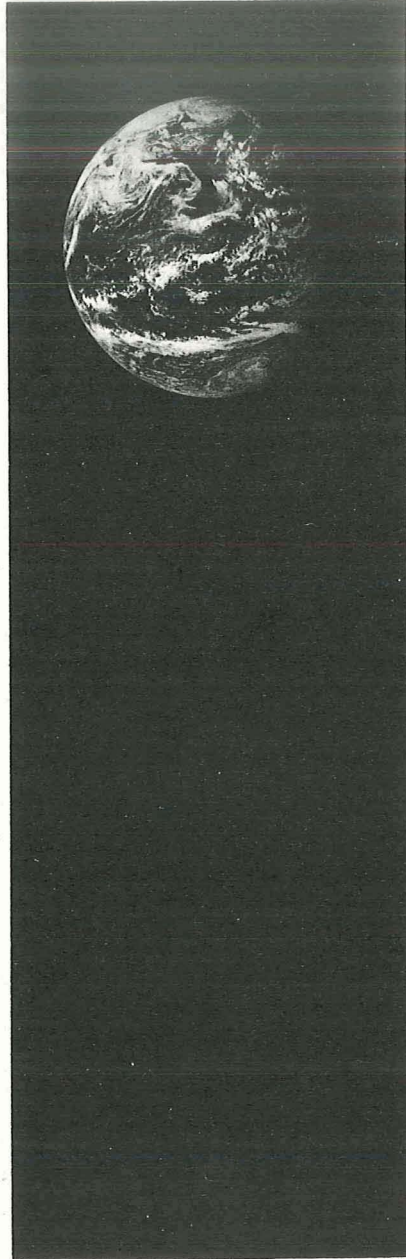
The Lands of Earth: The high places, the dry places, and the rivers tell us what happened in the past.

The Hand of Man: His activities have barely scratched the globe, but are increasingly affecting it.

Across North America: Its mountain ranges, plains, and coasts can now be seen from new vantage points.

Beyond This Island Earth: We have begun a new kind of exploration, with new vehicles, and endless horizons.

A foreword by NASA Acting Administrator George M. Low stresses how such photographs increase understanding of the relationships between our activities and environment.



NASA SP-250 1970 182 pp GPO \$6.00

The Book of Mars

By Samuel Glasstone

Similar in many respects to Earth, yet different, Mars has long figured importantly in science and technology and is currently a primary target for further efforts to gain fundamental knowledge of the solar system that is needed to meet challenges on Earth. Here, in one 315-page volume, is a summary of what men knew about Mars before the Mariner-Mars 1969 flights.

Dr. Samuel Glasstone, author of the *Sourcebook of the Space Sciences* and other highly regarded publications, reviews centuries of studies of the red planet, explains its place in the solar system, and sets forth clearly what is known about its atmosphere, clouds, haze, and surface. He turns then to theories concerning the origin of life, the formation of prebiological materials, and the possibility of finding life on Mars. After clarifying the challenge, he describes plans and requirements for detecting life on Mars, and avoiding contamination of this neighbor of the Earth while continuing its exploration.

This Special Publication won the Federal Editors Association's Blue Pencil Award as one of the outstanding Government publications of the year. It will serve as the baseline for future reports on Mars. "Nowhere have I found a more complete reference on Mars," D. David Batch of the Abrams Planetarium at Michigan State University reported. "Beautifully organized," F. C. Durant III of the Smithsonian Institution's National Air and Space Museum found.

NASA SP-179 1968 315 pp. GPO \$5.25

Mariner-Mars 1969: A Preliminary Report

This report reviews the most ambitious and successful planetary reconnaissance flight yet mounted by NASA, and summarizes scientific findings that surprised most of the world's astronomers. Mariners 6 and 7 obtained hitherto unobtainable data regarding the Martian atmosphere, and transmitted pictures 60 million miles to Earth that revealed distinct differences between the surface of Mars and that of the Moon. The sensors and telemetry, and first interpretations of the findings, are explained here by program leaders and principal investigators.

NASA SP-225 1970 145 pp. NTIS \$3.00

A Review of the Mariner IV Results

Mariner IV revealed the thinness of the atmosphere, moon-like craters, and other features of Mars to men. In this paper the director of Lunar and Planetary Programs of the NASA Office of Space Science and Applications describes the spacecraft, its trajectory, and the experiments that it carried on its journey to within 9487 kilometers of Mars. Engineering advances, technological lessons learned, and findings regarding the interplanetary environment are summarized.

NASA SP-130 1967 39 pp. GPO 25 cents

Mariner-Mars 1964: Final Project Report

This is a technical history of the first man-made probe to travel to Mars, from the inception of the project in 1962 until two-way communication with the spacecraft was interrupted October 1, 1965. Prepared by Jet Propulsion Laboratory, the report describes the trajectory, the vehicle, testing operations, the flight, the tracking and data acquisition, and the engineering and scientific results.

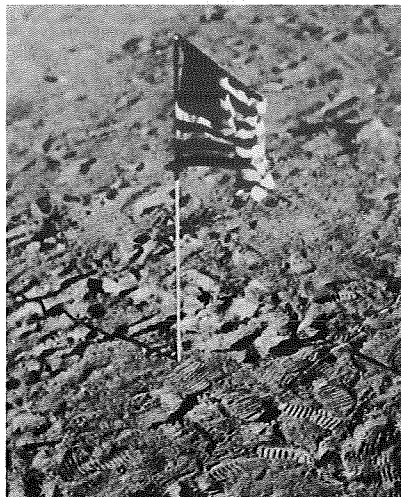
NASA SP-139 1968 346 pp. GPO \$2.50

Apollo 11: Preliminary Science Report

This report contains a photographic review of man's first landing on the Moon, the crew's observations, and scientists' accounts of the experiments carried out. The geologic setting of the lunar samples brought back, and findings in first examinations of these samples, are among the many matters authoritatively explained. Separate chapters deal with the passive seismic experiment, the laser ranging retro-reflector, the solar-wind composition experiment, the dust detector, and the closeup stereoscopic photography of the lunar surface. It can be a valuable reference work for all students of the solar system.

NASA SP-214 1969

204 pp. NTIS \$3.00



Apollo 12: Preliminary Science Report

The second manned landing on the Moon added significantly to scientists' knowledge of the Earth's nearest neighbor and demonstrated how its surface might be further explored. This preliminary report describes the apparatus set up, the collection of lunar soil and rocks, and the initial findings of the astronauts on a highly successful mission in 1969.

NASA SP-235 1970 240 pp. NTIS \$3.00

Analysis of Apollo 8 Photography and Visual Observations

Apollo 8 was the nearly flawless mission flown in December 1968 by Astronauts Borman, Lovell, and Anders preparatory to a landing on the Moon. The astronauts' own account of what they saw is followed by the initial photographic analysis by authorities on the equipment and areas pictured. Astronomical and Earth observations are also reported in this compilation by the NASA Manned Spacecraft Center.

NASA SP-201 1969 337 pp. GPO \$4.25

A Long-Range Program in Space Astronomy

Edited by Robert O. Doyle

This is a position paper of the Astronomy Missions Board headed by Dr. Leo Goldberg, Chairman of Harvard's Department of Astronomy, and charged with "the creation of an exciting, significant, and forward-looking long-range program in space astronomy." It contains recommendations of panels of leaders in such subdisciplines as X-ray and gamma-ray astronomy, fields and particle astronomy, and infrared space astronomy.

NASA SP-213 1969 305 pp. GPO \$1.50

Conference on Electromagnetic Exploration of the Moon

This brief report of a Program Evaluation Committee on a conference at the Ames Research Center in June 1968 discusses objectives, goals, criteria, and details of possible experiments on the Moon to help answer important problems of geophysical and geological interest.

NASA SP-174 1969 24 pp. NTIS \$3.00

The Moon as Viewed by Lunar Orbiter

By L. J. Kosofsky and Farouk El-Baz

With this scientific album, a reader can follow the Sun around the Moon, examine both its near and far sides, and see the depths of some of its craters in anaglyphs. Many of these beautifully reproduced pictures are 8½ by 11 inches. The scores included represent the cream of 3100 prints available, and have been meticulously captioned and indexed by the authors. The introduction describes the spacecraft, photographic system, and transmission and reproduction methods.

NASA SP-200 1970 152 pp. GPO \$7.75

Atlas of Cometary Forms: Structures Near the Nucleus

By Jurgen Rahe, Bertram Donn, and Karl Wurm

Photos and drawings of comets seen between 1835 and 1962 are reproduced for study in this atlas. Pertinent facts about each picture are given, but no interpretations are added. Comets are natural interplanetary probes, and both professional and amateur students of the solar system may find this picture book both intriguing and helpful. There is no comparable collection of pictures in the literature.

NASA SP-198 1968 128 pp. GPO \$2.25

Optical Space Communication

Edited by Robert S. Kennedy and Sherman Karp

Research recommended to solve problems of optical communication via free-space, atmospheric, and cloud channels is discussed in this account of a workshop at Williams College in 1968, sponsored by the Massachusetts Institute of Technology's Research Laboratory of Electronics and the NASA Electronics Research Center. Specialists in relevant areas of physical science participated under the guidance of communication engineers.

NASA SP-217 1970 147 pp. GPO \$1.50

Optical Telescope Technology

A continuing effort to design and develop large space observatories was the topic of a workshop April 29-May 1, 1969, at the Marshall Space Flight Center. This volume of proceedings includes discussion of requirements for telescopes in space observatories with 10 times the resolving power available now at Hale Observatories and capable of detecting stars 100 times fainter than those now detectable from the Earth's surface.

NASA SP-233 1970 800 pp. GPO \$6.25

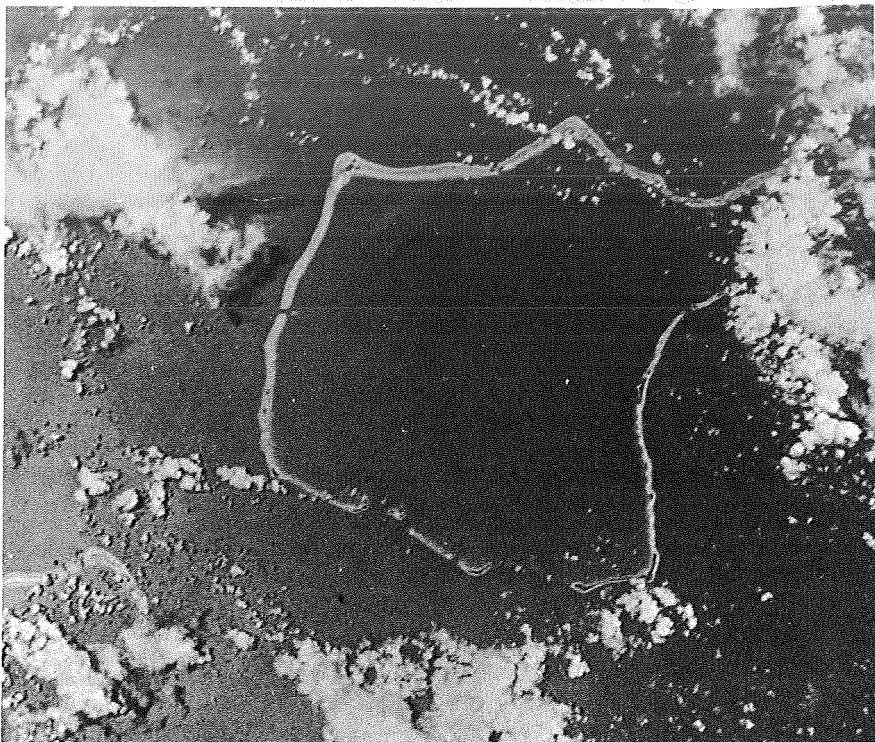
Surveyor: Program Results

This is the final report compiled by the Surveyor Program scientific team. It describes and reviews the findings of five unmanned spacecraft that landed and operated successfully on the lunar surface. Four of these craft examined widely separated mare sites in the Moon's equatorial belt; the fifth investigated a region deep in the southern highlands. Four Surveyors survived the extreme cold of the lunar night and operated for more than one lunar day/night cycle.

NASA SP-184 1969 425 pp. GPO \$4.75

Separate preliminary reports on Surveyors I, III, V, VI, and VII were published, respectively, as NASA SP-126, NASA SP-146, NASA SP-163, NASA SP-166, and NASA SP-173, and may be purchased from NTIS for \$3.00 each.

Ecological Surveys From Space



A space photo of Rongelap Atoll used to revise mariners' maps.

Feasible uses of spacecraft to help regain "a productive harmony between man and nature" in the 1970's are explained in this condensation of technical reports prepared for the Office of Space Science and Applications. Illustrated with color photographs of the Earth taken on Gemini and Apollo flights, it deals specifically with potentialities of remote sensing of Earth resources in seven disciplines: Geography, agriculture, forestry, geology, hydrology, oceanography, and cartography. Although intended mainly for specialists in these disciplines, it explains technical matters in language familiar to all laymen concerned with aspects of men's environment.

Described by one reviewer as a volume of "high-altitude photos with a purpose," this publication has been widely quoted.

NASA SP-230 1970 75 pp. GPO \$1.75

NASA Science and Technology Advisory Committee for Manned Space Flight

Subtitled "Proceedings of the Winter Study on Uses of Manned Space Flight, 1975-1985," this is the report of a conference at La Jolla, Calif., in December 1968 with Dr. Charles H. Towns as chairman. It deals with values, guidelines, and costs of space operations, and lunar, planetary and other programs. Volume II of Appendices contains papers written for the study. (The price covers both volumes.)

NASA SP-196 1969 369 pp. (2 vols.) NTIS \$3.00

Proceedings of the Seventh Annual Meeting of the Working Group on Extraterrestrial Resources

A semipermanent base on the Moon and means of determining its potentialities were discussed at this meeting in Denver in June 1968. The working group headed by James G. Gangler includes representatives of NASA, the U.S. Air Force, the U.S. Army, and the U.S. Bureau of Mines actively interested in using the resources of extraterrestrial bodies to reduce the dependence of lunar and planetary explorers on terrestrial supplies. Long-life electrical generators, drilling for water and gas, and use of the lunar vacuum for no-loss storage of cryogenic materials are among the subjects discussed.

NASA SP-229 1970 152 pp. GPO \$1.50

Fourth Symposium on the Role of the Vestibular Organs in Space Exploration

Topics discussed by participants in this symposium included historical aspects, etiology, symptomatology, treatment and prevention of motion sickness, sensory input of vestibular systems, sites of interaction and termination of vestibular systems, and acoustic problems. This symposium was held in 1968 at the Naval Aerospace Medical Center in Pensacola, Fla. (Proceedings of three previous symposiums are available in NASA SP-77, NASA SP-115 and NASA SP-152.)

NASA SP-187 1970 396 pp. GPO \$4.50

Status of Passive Inflatable Falling-Sphere Technology for Atmospheric Sensing to 100 km

The use of falling spheres as the primary sensors in meteorological rocket soundings was discussed at a September 1969 Langley Research Center meeting. Five papers in this volume review efforts of this sort, five emphasize techniques, and five deal with data obtained.

NASA SP-219 1970 302 pp. NTIS \$3.00

CO₂: Chemical, Biochemical, and Physiological Aspects

Twenty-six papers discussed at an international symposium sponsored by the National Heart Institute and NASA are presented in this volume of proceedings edited by Robert E. Forster, John T. Edsall, Arthur B. Otis, and F. J. W. Roughton. At this first major conference in several years on carbon dioxide in chemistry and animal biology, researchers reviewed theoretical aspects, carbamate reactions, carbonic anhydrase, metabolic processes, and carbon dioxide exchange rates in the body.

NASA SP-188 1970 291 pp. GPO \$2.75

Fourth Annual NASA-University Conference on Manual Control

This is a volume of formal and informal papers presented at a University of Michigan meeting in 1968 during sessions on: Quasi-linear describing function theory; quasi-linear describing function applications; human performance theory; analysis of adaptive or higher order control processes; system identification signal analysis and performance measurement; effects of environmental variables on performance; developments in control and display system design; development of models based on discrete signal processing; and neuromuscular system analysis.

NASA SP-192 1969 594 pp. NTIS \$3.00

Earth Photographs From Gemini VI Through XII

To show the Earth as the astronauts have seen it, the color photographs in this volume are arranged as if taken on a single flight around the world. The first views are of the Florida peninsula. These are followed by unprecedented pictures of the Canary Islands; the deserts, shores, and mountains of Africa; the Arabian peninsula, India, remote equatorial seas and lands; and the peaks, jungles, and rivers of South America and Mexico. Then the pictures lead the reader along the Gulf coast of the United States and back to Cape Kennedy. Captions call attention to geological, oceanographic, meteorological, and industrial uses for such photography, and heighten one's appreciation of the Earth's beauty.

Areas covered by the photos are indicated on special maps, and additional pictures available to Earth scientists are listed and described.

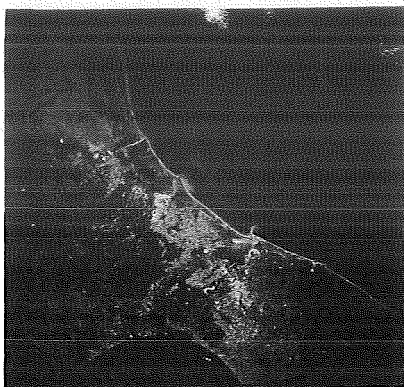
NASA SP-171 1969 327 pp. GPO \$8.00

Earth Photographs From Gemini III, IV, and V

In this volume the photographs taken on each flight are grouped together. These photos, taken with hand-held cameras, were historic demonstrations of the advantages of seeing the Earth from higher altitudes than anyone ever had seen it before. Such pictures have heightened many men's hopes of monitoring and managing the Earth's riches more efficiently for the benefit of all mankind.

Scientific potentialities are emphasized in both this volume and NASA SP-171. Together the two volumes of Gemini pictures constitute a guidebook to pictorial information that the program made available to cartographers, geologists, and other investigators of the Earth's surface.

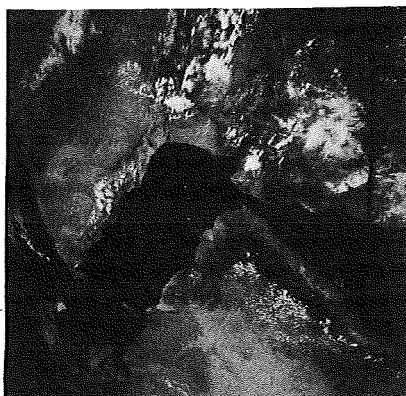
NASA SP-129 1967 276 pp. GPO \$7.00



The Texas coast.



Africa's geology.



Shores of Arabia.

Average Evoked Potentials: Methods, Results, and Evaluations

Edited by Emanuel Donchin and Donald B. Lindsley

Human neural responses to specific stimuli may be evaluated by the average potential of the nervous system, and the use of averaging techniques may greatly expand the use of electroencephalograms. The American Institute of Biological Sciences and NASA sponsored a conference in 1968 at San Francisco on the state of this art, and this volume contains the proceedings, followed by an impressive bibliography of recent research work.

NASA SP-191 1969 400 pp. GPO \$2.00

Interdisciplinary Approach to Friction and Wear

Edited by P. M. Ku

H. C. Gatos, J. B. P. Williamson, F. F. Ling, M. E. Merchant, J. F. Archard, D. Godfrey, D. Tabor, and K. R. Lawless were among the engineers, researchers, and scientists who took part in the symposium recorded in this volume. Arranged by the Southwest Research Institute, the 3-day meeting in San Antonio, Tex., in 1967, dealt primarily with sliding friction and wear under lubricated and boundary-lubrication conditions.

NASA SP-181 1968 486 pp. GPO \$2.25

The Prevention of Electrical Breakdown in Spacecraft

By Fred W. Paul and Donald Burrowbridge

After describing phenomena associated with electrical breakdowns, the Goddard Space Flight Center authors of this monograph explain design principles, fabrication practices, and test considerations. Requirements for the high voltage protection of the Mariner-Mars 1969 equipment are recalled, along with a rudimentary checklist. Gas discharges are emphasized, and a sample design specification from the Jet Propulsion Laboratory is included.

NASA SP-208 1970 96 pp. NTIS \$3.00

Introduction to Abstract Analysis

By Marvin E. Goldstein and Burt M. Rosenbaum

Based on lectures given at the Lewis Research Center, this publication introduces readers familiar with applied mathematics to concepts of abstract analysis. The authors' objective was to help engineers and scientists understand the literature of pure mathematics. Proofs are more detailed than in many texts, and examples are given to illustrate concepts. Background needed to read the literature of pure mathematics is emphasized.

NASA SP-203 1970 247 pp. GPO \$2.25

Plasmas and Magnetic Fields in Propulsion and Power Research

Eight papers prepared for a 1969 Lewis Research Center conference deal with electric rockets, magnetogasdynamic power generation, plasma heating and containment, thermionic plasmas, cryogenic and superconducting magnets, solid-state physics in intense magnetic fields, simulation of solar-wind phenomena, and plasma chemistry and ion-molecule interactions. Inadequacies as well as potentialities of propulsion systems for exploration of the solar system are discussed.

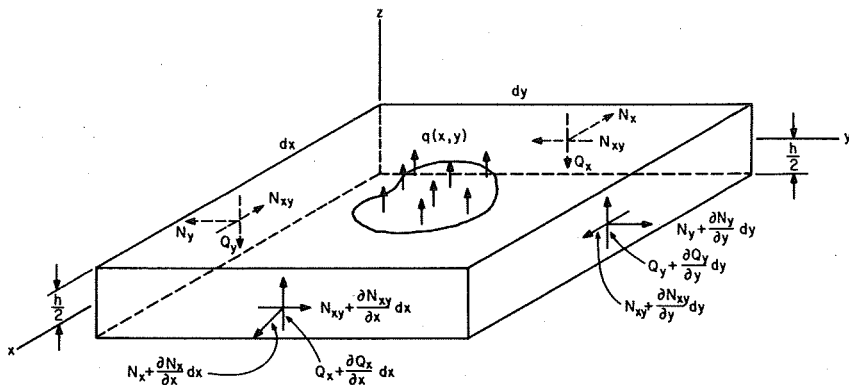
NASA SP-226 1970 240 pp. NTIS \$3.00

Vibration of Plates

By Arthur W. Leissa

To reduce duplication of research in plate vibrations, the author has summarized results available in the literature through 1965. Results include those for the simplest classical theories of plates as well as for complications such as anisotropy, in-plane force, and variable thickness. Only analytical results from two-dimensional-plate theories are considered.

NASA SP-160 1970 353 pp. GPO \$3.50



Forces (intensities) acting on a plate element.

Evaluation of Motion-Degraded Images

Degradation of photos by motion has become a matter of much concern in both space exploration and astronomy. The current state of the art is clarified by the 24 papers in this volume, presented at a 1968 seminar sponsored by the NASA Electronics Research Center in Cambridge, Mass.

NASA SP-193 1969 192 pp. GPO \$2.00

Future Fields of Control Application

A report of a symposium in 1969 at the Massachusetts Institute of Technology at which participants discussed applications of control theory to publishing, to oceanography, to biological cybernetics, and to other disciplines and activities, including World Bank operations.

NASA SP-211 1969 146 pp. NTIS \$3.00

Kinetics and Thermodynamics in High-Temperature Gases

Basic research at Lewis Research Center was described at a conference there in March 1970. This volume includes proceedings in sessions on chemical equilibria, transport phenomena, and chemical kinetics.

NASA SP-239 1970 152 pp. NTIS \$3.00

Electric Propulsion Mission Analysis

This pamphlet, prepared by a task group of the NASA Office of Advanced Research and Technology, recommends terminology and nomenclature to establish a common language for low-thrust mission studies.

NASA SP-210 1969 10 pp. NTIS \$3.00

Progress of NASA Research on Warm Fog Properties and Modification Concepts

Characteristics of warm fog and seeding experiments to improve visibility at airports are discussed in this report of proceedings at a NASA conference in 1969. Attention is focused on efforts at Cornell Aeronautical Laboratory since 1962 to modify fog, dissipate it, and simulate seeding of fog.

NASA SP-212 1969 122 pp. NTIS \$3.00

Basic Aerodynamic Noise Research

To review studies of aircraft noise and determine directions for future research, 200 specialists on the problem met in July 1969 at NASA Headquarters to hear presentations of the 31 papers included in this volume of proceedings. They deal with theoretical and experimental aspects of jet exhaust, rotating fan, inlet duct, and boundary-layer noise research. NASA SP-207 1969 535 pp. GPO \$2.25

Analysis of a Jet in a Subsonic Crosswind

This volume consists of 15 papers presented by university and industrial researchers at a Langley Research Center symposium in September 1969 for persons concerned with aerodynamic characteristics of VSTOL aircraft. Five papers include experimental results and 10 deal with empirical and analytical descriptions of jets and induced flows. NASA SP-218 1969 249 pp. NTIS \$3.00

NASA Acoustically Treated Nacelle Program

Final results of a NASA acoustically treated nacelle program conducted by the Boeing Co. and McDonnell Douglas Corp. are reported in this volume, as given at a Langley Research Center conference in October 1969. Flight tests and economic implications are reviewed. NASA SP-220 1969 165 pp. NTIS \$3.00

Aerospace Food Technology

Methods of feeding men in spacecraft, submarines, aircraft, and in other unusual circumstances were discussed at a conference of food scientists and engineers sponsored by the National Academy of Sciences and NASA in April 1969 at the University of South Florida. Papers reviewing findings and recent research are reproduced in this volume. NASA SP-202 1970 224 pp. NTIS \$3.00

Compressible Turbulent Boundary Layers

Skin friction, heating, profiles, and other characteristics of compressible turbulent boundary layers were discussed at a Langley Research Center conference in December 1968. Twenty papers deal with analytic approaches, turbulence ablation, and three-dimensional, interacting, and inlet flows.

NASA SP-216 1969 567 pp. NTIS \$3.00

Analytic Methods in Aircraft Aerodynamics

This is a collection of technical papers presented in October 1969 at an Ames Research Center symposium, Moffett Field, Calif., concerned with pressure and forces on basic shapes, flow fields, boundary layers and shock-boundary-layer interactions, internal aerodynamics, and configuration aerodynamics.

NASA SP-228 1970 742 pp. NTIS \$3.00

Sonic Boom Research

A. R. Seebass, Ed.

Possible means of reducing sonic boom overpressures, and the adequacy of current research, were discussed at NASA Headquarters April 12, 1967. This volume contains five invited papers presented at that conference on basic theory, the effects of airplane operations and the atmosphere on sonic booms, and the effects of sonic booms on people and structures.

NASA SP-147 1967 118 pp. GPO 50 cents

Second Conference on Sonic Boom Research

Ira A. Schwartz, Ed.

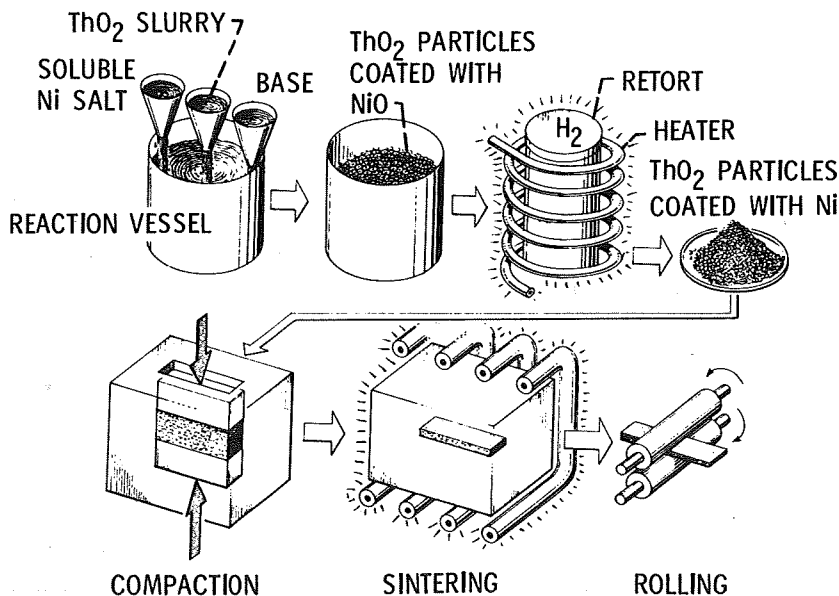
A year's progress in developing methods of analysis and devising means of reducing sonic boom for practical aircraft design was reviewed at a conference at NASA Headquarters, May 9-10, 1968. Nineteen invited papers and the contributed remarks clarify promising avenues for research.

NASA SP-180 1968 193 pp. GPO \$1.00

Aerospace Structural Materials

The many aspects of materials research at Lewis Research Center are suggested by the 22 technical papers prepared for a 1969 conference in Cleveland and assembled in this volume. Topics include fracture prevention and life prediction, superalloys for high temperatures, refractory materials, fiber composites, analysis and special preparation methods, and environmental effects and protection.

NASA SP-227 1970 330 pp. NTIS \$3.00



Chemical precipitation approach to dispersion-strengthened materials.

Introduction to Experimental Techniques of High-Energy Astrophysics

By H. Ogelman and J. R. Wayland

Six lectures prepared for a graduate course jointly presented by the University of Maryland and Goddard Space Flight Center deal with measurements of non-relativistic charged particles of extraterrestrial origin, X-ray detectors, high-energy photon detectors, extensive air showers, and radio-astronomical observations of high-energy particles.

NASA SP-243 1970 255 pp. NTIS \$3.00

Applications of Research on Human Decisionmaking

Edited by R. M. Patten, T. A. Tanner, Jr., J. Markowitz, and J. A. Swets

The increasing complexity of man-machine systems in large and fast aircraft, manned spacecraft, and ground-based control facilities prompted the Human Performance Branch of the Biotechnology Division of the Ames Research Center to sponsor a symposium in February 1968. This volume of proceedings reports the papers presented, comments, and conclusions.

NASA SP-209 1970 195 pp. GPO \$2.00

Holographic Instrumentation Applications

Edited by Boris Ragent and Richard M. Brown

Recent developments, trends, and potentialities of holographic instrumentation were reviewed by NASA and associated authorities at an Ames Research Center meeting in January 1970. Twenty-three of the papers are summarized here with an introduction by Wolfgang Menzel of NASA Headquarters. They describe holographic measurement techniques being studied both at NASA centers and by contractors.

NASA SP-248 1970 241 pp. NTIS \$3.00

Fifth Annual NASA-University Conference on Manual Control

The Massachusetts Institute of Technology and NASA jointly sponsored this 1969 conference of specialists from the United States, Canada, Germany, and Holland. It dealt with quasi-linear models, display systems, optimal control methods, adaptive and discrete models, human performance theory, neuromuscular models, monitoring, and applications. Most of the formal papers that were presented will be found in this publication.

NASA SP-215 1970 713 pp. NTIS \$3.00

EXAMETNET Data Report Series: Annual Report 1968

The Experimental Inter-American Meteorological Rocket Network is a cooperative program of Argentina, Brazil, and the United States to demonstrate capabilities of an interhemispheric network of sounding rocket launch sites. This is the third annual publication of data reported from the three countries.

NASA SP-231 1970 173 pp. NTIS \$3.00

Portable Life-Support Systems

Problems of providing a hospitable microenvironment for a man are often similar in space, military, mining, and other endeavors. Twenty-four contributions to an Ames Research Center conference in 1969 on requirements for garments, etc., are reported in this volume. Contributors to this conference considered the pitfalls in preparing physiological design specifications and discussed various means of avoiding them.

NASA SP-234 1970 389 pp. NTIS \$3.00

Interstellar Grains

J. Mayo Greenberg and T. P. Roark, Eds.

Assembled here for reference use are the reports and remarks of several nations' scientists at a colloquium on interstellar grains at the Rensselaer Polytechnic Institute, August 24 to 26, 1965. The topics discussed included the formation, growth, scattering properties, and interactions of grains with the interstellar medium, polarization and its dependence on wavelength and spatial distribution, and granular extinction. The conference was under the auspices of the National Science Foundation and supported by NASA and the New York State Atmospheric Sciences Research Center.

NASA SP-140 1967 269 pp. GPO \$1.25

Fuel Cells

By L. G. Austin

Hundreds of reports of investigations for U.S. Government agencies were the basis for this guide to the past and future of fuel-cell technology. Information no longer readily available is summarized here to facilitate work in this rapidly changing field. Research on hydrogen-oxygen, hydrocarbon, amalgam, thermally regenerative, thermogalvanic, redox, hydrazine, ammonia, and biochemical fuel cells is discussed. Construction and manufacturing techniques are covered. So, too, are both theories and the various potential uses for different types of fuel cells.

NASA SP-120 1967 439 pp. GPO \$2.75

Scientific Satellites

By William R. Corliss

This is a comprehensive study of unmanned scientific satellites by an engineer noted for his skill in technical reporting. It covers the period from 1957, when a Russian satellite first beeped its greetings, through 1966. One major section deals with missions and spacecraft, and another with scientific instruments. Designs, experiments, capabilities, and orbits are recorded. A general bibliography and an appendix giving specifications of scientific satellites enhance the value of the work to students.

NASA SP-133 1968 822 pp. GPO \$3.00

Bioenergetics of Space Suits for Lunar Exploration

A Literature Review by Emanuel M. Roth

This report discusses the new problems in optimal space-suit system design presented by the potential for severe physical exertion outside the spacecraft and on the surface of the Moon and other celestial bodies. Subjects covered include the metabolic load imposed on humans by exertion, the mechanics of locomotion under varied terrain and gravity conditions, mobility restriction in space suits, and problems of thermal control.

NASA SP-84 1966 140 pp. GPO \$1.00

Meteor Orbits and Dust: Proceedings of a Symposium

Gerald S. Hawkins, Ed.

Published simultaneously by NASA and as Volume II of the "Smithsonian Contributions to Astrophysics," this volume contains 20 papers prepared for a symposium sponsored by NASA and the Smithsonian Institution Astrophysical Observatory, August 8 to 13, 1965, in Cambridge, Mass. It includes flight data on meteoroid penetration hazards obtained by Pegasus I and II and smaller Explorer satellites.

NASA SP-135 1967 412 pp. GPO \$2.50

Oxide Dispersion Strengthened Alloys

By Nicholas J. Grant, Howard J. Siegel, and Robert W. Hall

In this report, prepared for the NASA Research Advisory Committee on Materials, the authors sought to explain why oxide dispersion strengthened alloys have not achieved greater commercial success. Their report points to major gaps in knowledge of these alloys and recommends expanded support of studies of them.

NASA SP-143 1967 25 pp. GPO 15 cents

Batteries for Space Power Systems

By Paul Bauer

Completed portions of NASA's work on batteries and related subjects are summarized in this volume. Hermetically sealed cells, nonmagnetic batteries, and charge control devices are among the new products that have resulted. Sterilizable cells, high-impact-resistant batteries, long shelf life and 5-year working life power packs are being readied for use. Major emphasis is on development work and general, rather than specialized, data. Thermodynamics is stressed more than other theoretical aspects because of its importance in solving thermal problems associated with battery operation.

NASA SP-172 1969 306 pp. GPO \$1.50

Recent Advances in Display Media

How can computer-generated information best be displayed in advanced aircraft and spacecraft? Fifteen papers given at a symposium sponsored by the Electronics Research Center in Cambridge, Mass., September 19 and 20, 1967, deal with aspects of this art. Thermochromic, fluidic, magnetic, electrostatic, laser and other display devices are among those considered.

NASA SP-159 1968 146 pp. GPO \$1.00

Bioregenerative Systems

Proceedings of a conference sponsored by the American Institute of Biological Sciences and NASA, at Washington, in November 1966, include papers on the chemosynthetic approach to a closed bioregenerative life-support system, and related matters including the multidisciplinary research program dealing with the organism *Hydrogenomonas*.

NASA SP-165 1968 153 pp. GPO \$1.50

Lunar Orbiter I Preliminary Results

J. Kenrick Hughes and Gerald W. Brewer of Langley Research Center compiled this report on lunar terrain assessment and selenodesy, micrometeoroid, and radiation measurements by scientists and engineers concerned with a highly successful mission in 1966. An appendix includes geologic terrain maps.

NASA SP-197 1969 141 pp. NTIS \$3.00

Significant Accomplishments in Science, Goddard Space Flight Center, 1968

This is an almost verbatim transcript of 44 very short papers presented in January 1969 at the Goddard Space Flight Center by members of its Space Sciences Directorate, regarding achievements in the Earth sciences, astronomy, physics, etc.

NASA SP-195 1969 188 pp. NTIS \$3.00

Gemini Summary Conference



Astronauts Lovell and Borman returning from Gemini 7 flight.

Participants summarize the major results of the 10 manned flights of the Gemini Program in this Special Publication. It contains 21 technical papers presented at a Gemini Summary Conference on February 1 and 2, 1967, at the NASA Manned Spacecraft Center in Houston, and 49 color photographs taken by the astronauts.

Appendices list the NASA centers, other Government agencies, contractors, sub-contractors, and vendors involved in the historic Gemini program.

NASA SP-138 1967 345 pp. GPO \$2.75

"Gemini Midprogram Conference" (NASA SP-121 1966 444 pp. GPO \$2.75) contains 46 papers presented at a conference at Houston in February 1966.

Summary of Gemini Extravehicular Activity

Reginald M. Macbell, Ed.

The NASA Manned Spacecraft Center staff reviews the lessons of 12 hours and 25 minutes of extravehicular activity in this report, which includes recommendations regarding restraints, space suits, training, and other requirements. The development of life support systems, umbilical and tether combinations, and maneuvering equipment is recalled.

NASA SP-149 1968 336 pp. NTIS \$3.00

Relay Program Final Report

This Goddard Space Flight Center report compares the performance of Relay I and Relay II, satellites launched in 1962 and 1964, and reviews experiments conducted with them by ground stations in the United States and other countries.

(This is a sequel to "Relay I Final Report," NASA SP-76, 1965, 767 pp. GPO \$1.75.)

NASA SP-151 1969 365 pp. GPO \$3.25

Orbiting Solar Observatory Satellite OSO I: The Project Summary

A description of the work performed in connection with the Orbiting Solar Observatory, launched March 7, 1962, including details on spacecraft dynamics, structural design and fabrication, control systems, data acquisition and command systems, power supply, thermal control, testing, and experiments carried out with the OSO I.

NASA SP-57 1966 306 pp. GPO \$2.00

Survey of the Literature on the Solar Constant and the Special Distribution of Solar Radiant Flux

By M. P. Thekaekara

Survey of currently available data on this subject, including a discussion of relevant theoretical considerations concerning radiation, solar physics, scales of radiometry, and the thermal balance of spacecraft.

NASA SP-74 1965 43 pp. NTIS \$3.00

Concepts for Detection of Extraterrestrial Life

Freeman H. Quimby, Ed.

The devices and instruments described in this illustrated booklet are among those planned for inclusion in vehicles designed to land on planets such as Mars. They constitute techniques for detecting growth and metabolism, for determining the presence of biologically significant molecules, and for actual visual observation of microorganisms and the planetary terrain.

NASA SP-56 1964 53 pp. GPO 50 cents

An Analysis of the Extraterrestrial Life Detection Problem

By Richard S. Young, Robert B. Painter, and Richard D. Johnson

Guidelines and ground rules for a cohesive study of the solar system and beyond for evidences of life—past, present, or future. The study includes a section on "The Attributes of Life."

NASA SP-75 1965 33 pp. NTIS \$3.00

A Survey of Attitude Sensors for Spacecraft

By Norman M. Hatcher

The fundamental principles of operation of horizon scanners, solar sensors, star trackers, space sextants, map matchers, and other sensors are set forth in this monograph to facilitate understanding of their use. The performance of many sensors in space is mentioned, and current research and problem areas are indicated.

NASA SP-145 1967 18 pp. NTIS \$3.00

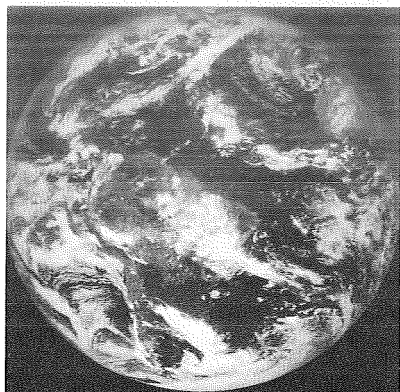
Protection Against Space Radiation

Special sessions of the American Nuclear Society's 13th annual meeting, at San Diego, Calif., in June 1967, dealt with this topic. This volume records the proceedings. Four principal topics of interest were: Basic interactions and transport of space radiation in materials, means of calculating space radiation shield penetration, shield design, and advanced shielding concepts.

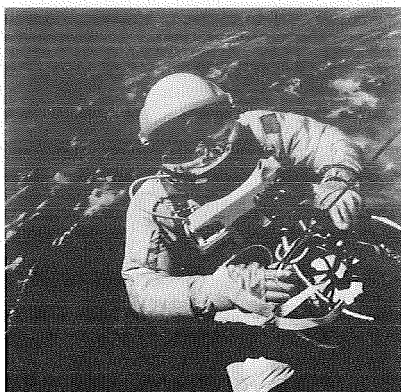
NASA SP-169 1968 600 pp. NTIS \$3.00

Proceedings of a conference in 1964, sponsored by AEC, USAF, and NASA, on the same topic are also available: Second Symposium on Protection Against Radiations in Space.

NASA SP-71 1965 551 pp. GPO \$3.00



The Western Hemisphere.



A Gemini cameraman.

Exploring Space With a Camera

Edited by Edgar M. Cortright

From tens of thousands of pictures taken during the first 10 years of space exploration, Edgar M. Cortright, who is now Director of the Langley Research Center, chose the most historic and striking. Then he persuaded outstanding authorities to caption them, and so arranged them as to trace the sequence of developments.

The pictures include meteorological and other photos obtained from unmanned satellites; dramatic views of the Earth's continents, seas and cities as the Gemini astronauts saw them; close-ups

and panoramas of the Moon's surface, and the best views of Mars obtained prior to the 1969 efforts. Many of the photos in this unusual album are reproduced in full color.

"I hope this book can find its way into many American homes," NASA's former Administrator, James E. Webb, wrote, "for it is a part of a record of achievement of which our country can be proud." More than 100,000 copies of this outstanding publication has been sold and repeated printings have been necessary.

NASA SP-168 1968 214 pp. GPO \$4.25

Dictionary of Technical Terms for Aerospace Use

William H. Allen, Ed.

This first edition of a dictionary for space scientists and technologists contains more than 6000 carefully chosen and precisely defined terms. It does not attempt, however, to include every aspect of space terminology.

NASA SP-7 1965 314 pp. GPO \$3.00

Short Glossary of Space Terms

Brief definitions of frequently used space terms, selected from the *Dictionary of Technical Terms for Aerospace Use* (NASA SP-7). Second edition.

NASA SP-1 1966 52 pp. GPO 25 cents

GENERAL SERIES

17

Space Cabin Atmospheres

Part I: Oxygen Toxicity

Part II: Fire and Blast Hazards

Part III: Physiological Factors of Inert Gases

Part IV: Engineering Tradeoffs of One- Versus Two-Gas Systems

These are open literature reviews by Emanuel M. Roth, relating oxygen to other factors of concern in space cabins, discussing environmental hazards, noting physiological effects of chemically inert gases, and engineering considerations. Dr. Roth's review was prepared for NASA under a contract with the Lovelace Foundation for Medical Education at Albuquerque, N. Mex.

NASA SP-47 Part I 1964 51 pp. GPO 40 cents

NASA SP-48 Part II 1964 119 pp. GPO \$1.00

NASA SP-117 Part III 1967 136 pp. GPO \$1.00

NASA SP-118 Part IV 1967 132 pp. GPO \$1.00

Symposium on Computer Simulation of Plasma and Many-Body Problems

Techniques, philosophies, and potentialities of computer simulation of classical many-body problems were discussed at a symposium sponsored by the NASA Langley Research Center and the College of William and Mary, April 19 to 21, 1967, in Williamsburg, Va. Most of the proceedings in this volume deal with long-range forces and collective effects such as those that occur in plasmas and astrophysical systems, but several neutral-gas problems also were considered.

NASA SP-153 1967 440 pp. NTIS \$3.00

Proceedings of a Symposium on Passive Gravity-Gradient Stabilization

Proceedings of a symposium held at Ames Research Center, May 10-11, 1965, to document the current state of the art in hardware development for gravity-gradient control systems.

NASA SP-107 1966 269 pp. GPO \$1.75

Philosophy of Simulation in a Man-Machine Space Mission System

An examination of the philosophy of simulation as it pertains to manned space activities, with particular orientation to research in the life sciences, by Dr. T. M. Fraser, stresses prerequisites, difficulties, and usefulness of an important modern technology.

NASA SP-102 1966 107 pp. GPO 50 cents

Proceedings of a Conference on Theoretical Biology

A series of discussions on de novo cell synthesis and population ecology held at Princeton, N.J., November 22-24, 1963, under the sponsorship of NASA and the American Institute of Biological Sciences.

NASA SP-104 1966 188 pp. GPO \$1.00

Progress in Development of Methods in Bone Densitometry

Proceedings of a conference held in Washington, D.C., March 25-27, 1965, under the joint sponsorship of NASA, the National Institute of Arthritis and Metabolic Diseases (NIH), and the American Institute of Biological Sciences.

NASA SP-64 1966 204 pp. GPO \$1.50

COLLEGE TEXTS ON SPACE TECHNOLOGY

Five volumes of a series of short basic texts on space technology for upper-level college engineering students have been published. They were based on notes prepared for summer courses at the California Institute of Technology and the University of California at Los Angeles. The concept underlying these Institutes was to acquaint and interest outstanding undergraduates in the rapidly developing technology created by the exploration of space.

Space Technology

Vol. I: Spacecraft Systems, <i>by L. H. Abraham</i>	NASA SP-65	1965	85 pp.	GPO	35 cents
Vol. II: Spacecraft Mechanical Engineering, <i>by J. L. Adams</i>	NASA SP-66	1965	166 pp.	GPO	60 cents
Vol. IV: Spacecraft Guidance and Control, <i>by J. R. Scull</i>	NASA SP-68	1967	143 pp.	GPO	55 cents
Vol. V: Telecommunications, <i>by J. J. Stiffler</i>	NASA SP-69	1967	142 pp.	GPO	55 cents
Vol. VI: Space Sciences, <i>by T. A. Farley</i>	NASA SP-114	1967	84 pp.	GPO	35 cents

Significant Achievements in Space Science 1967

Summarized here are a year's advances in Stellar Astronomy, Space Bioscience, Ionospheres and Radio Physics, Particles and Fields, Planetary Atmospheres, Planetology, and Solar Physics. Contributors to each section were recognized authorities on these disciplines.

NASA SP-167 1969 558 pp. GPO \$2.50

Similar reviews of achievements in preceding years are available in:

Significant Achievements in Space Science 1966, NASA SP-155 1968 419 pp. GPO \$1.50; Significant Achievements in Space Applications 1966, NASA SP-156 1968 91 pp. GPO 50 cents; Significant Achievements in Space Science 1965, NASA SP-136 1967 218 pp. GPO \$1; and Significant Achievements in Space Applications 1965, NASA SP-137 1967 85 pp. GPO 45 cents.

For the convenience of readers, advances in 10 scientific disciplines during the 1958-to-1964 period have been summarized in separate volumes:

Significant Achievements in Space Astronomy 1958-1964, NASA SP-91 1966 73 pp. GPO 45 cents; Significant Achievements in Space Bioscience 1958-1964, NASA SP-92 1966 128 pp. GPO 55 cents; Significant Achievements in Space Communications and Navigation 1958-1964, NASA SP-93 1966 68 pp. GPO 45 cents; Significant Achievements in Satellite Geodesy 1958-1964, NASA SP-94 1966 174 pp. GPO 60 cents; Significant Achievements in Ionospheres and Radio Physics 1958-1964, NASA SP-95 1966 60 pp. GPO 45 cents; Significant Achievements in Satellite Meteorology 1958-1964, NASA SP-96 1966 141 pp. GPO 60 cents; Significant Achievements in Particles and Fields 1958-1964, NASA SP-97 1966 94 pp. GPO 50 cents; Significant Achievements in Planetary Atmospheres 1958-1964, NASA SP-98 1966 59 pp. GPO 45 cents; Significant Achievements in Planetology 1958-1964, NASA SP-99 1966 71 pp. GPO 45 cents; Significant Achievements in Solar Physics 1958-1964, NASA SP-100 1966 96 pp. GPO 50 cents.

Ranger IX Photographs of the Moon: Cameras "A," "B," and "P"

This is the fifth in a series of volumes of photographs of the Moon taken by the Rangers. It shows 170 selected Ranger IX frames.

NASA SP-112 1966 187 pp. GPO \$6.50

The other volumes in this series are: Ranger VIII Photographs of the Moon: Cameras "A," "B," and "P," NASA SP-111 (1966 187 pp. GPO \$6.50); Ranger VII Photographs of the Moon, Part I, Camera "A" Series, NASA SP-61 (1964 226 pp. GPO \$6.50); Part II, Camera "B" Series, NASA SP-62 (1965 217 pp. GPO \$6.50); and Part III, Camera "P" Series, NASA SP-63 (1965 200 pp. GPO \$6.50).

The Meteoroid Environment and Its Effects on Materials and Equipment

By William A. Cosby and Robert G. Lyle

A detailed study, prepared by the National Academy of Sciences, of publications appearing since 1960 on the meteoroid environment and its effects on materials and equipment. Divided into sections on: Environment, Hypervelocity Impact Phenomena, and Design Considerations. NASA SP-78 1965 116 pp. GPO 50 cents

Medical Aspects of an Orbiting Research Laboratory

A report by the Space Medicine Advisory Group (SPAMAG), a group of consultants representing varied disciplines in the life sciences. Recommendations fall in three broad categories: (1) life support; (2) experiments to test the response in the space environment; and (3) research laboratory design and operation. Twenty authorities representing 16 medical specialties and sub-specialties took part in this preliminary study.

NASA SP-86 1966 144 pp. GPO \$1.00

Human Response to Sustained Acceleration

A Literature Review by T. M. Fraser

A critical review of the open literature in the field, this report deals with the natural history and physiological effects of sustained acceleration and with human tolerance and performance.

NASA SP-103 1966 136 pp. GPO \$1.00

Fifth National Conference on the Peaceful Uses of Space

Proceedings of a 1965 meeting in St. Louis of representatives of industry, the scientific community, and government to review accomplishments, goals, future programs, and the impact of space exploration on industry, communication, education, philosophy, and society.

NASA SP-82 1966 200 pp. GPO \$1.50

Proceedings of National Conferences on the Peaceful Uses of Space in preceding years are available in NASA SP-51 (1964 226 pp. GPO \$1.50), NASA SP-40 (1963 301 pp. GPO \$2.00), and NASA SP-8 (1962 282 pp. GPO \$1.50).

A Study of NASA University Programs

NASA's impact on the nation's universities and their influence on the space program are assessed in this report by a Task Force that compiled the available data, interviewed NASA managers, visited five universities, and examined results of the agency's efforts in four disciplines.

NASA SP-185 1968 79 pp. NTIS \$3.00

Aerospace Electronic Systems Technology: A Briefing for Industry

NASA spokesmen explained current and upcoming mission goals and demands upon aerospace technology at a briefing for industry sponsored by the Electronics Industries Association, May 3 and 4, 1967, at the Massachusetts Institute of Technology. The proceedings recorded in this volume delineate the role of the Electronics Research Center in Cambridge, Mass., and include discussions of the state of Earth orbital technology, lunar and planetary technology, and avionics.

NASA SP-154 1968 290 pp. GPO \$1.25

The Zodiacal Light and the Interplanetary Medium

J. L. Weinberg, Ed.

An international symposium sponsored by the International Astronomical Union, the American Institute of Aeronautics and Astronautics, and NASA, at Honolulu in 1967, yielded this volume of proceedings. Papers included deal with photometric observations, particle collection and impact, meteor observations, scattering properties, solar winds, and origins and evaluation of zodiacal dust clouds.

NASA SP-150 1968 430 pp. GPO \$3.00

Astronomy in Space

Three papers presented at the 121st meeting of the American Astronomical Society in March 1966 by Homer E. Newell, Henry J. Smith, and Nancy G. Roman on, respectively, the NASA space astronomy program, solar astronomy, and stellar and galactic astronomy—plus an account of expanding vistas in astronomy by George E. Mueller.

NASA SP-127 1967 67 pp. GPO 45 cents

Ariel I: The First International Satellite

A summary document prepared by the Goddard Space Flight Center on a pilot project in international cooperation between the United States and the United Kingdom to study the ionosphere and its relation to the Sun. The satellite's structure and major subsystems, and the tracking, data acquisition and data reduction operations are described.

NASA SP-119 1967 158 pp. GPO \$1.50

Aerospace Measurement Techniques

Gene G. Manella, Ed.

Possible bases for new instrumentation concepts were considered at a Massachusetts Institute of Technology symposium in July 1966, sponsored by the NASA Electronics Research Center.

NASA SP-132 1967 261 pp. GPO \$1.00

Spacecraft Sterilization Technology

This volume contains 36 papers prepared for a conference at the Jet Propulsion Laboratory in November 1965. Four of them explain NASA's efforts to facilitate the search for extraterrestrial life by preventing contamination of the findings.

NASA SP-108 1967 630 pp. GPO \$2.25

Short-Term Frequency Stability

Proceedings of the IEE-NASA Symposium on the Definition and Measurement of Short-Term Frequency Stability held at the Goddard Space Flight Center, Greenbelt, Md., November 23-24, 1964.

NASA SP-80 1965 317 pp. GPO \$1.75

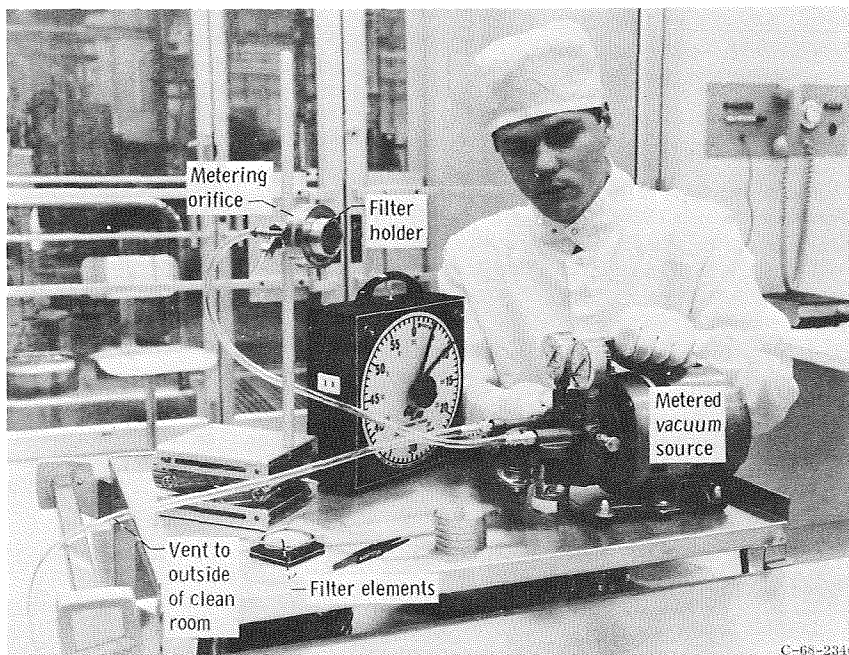
Technology Utilization Series

Contamination Control Principles

By H. D. Sivinski, W. J. Whitfield, and W. L. Clement

In this well publicized report, Willis J. Whitfield (whom *Time Magazine* calls "Mr. Clean") and his colleagues at the Sandia Corporation in Albuquerque, N. Mex., present a basic model for contamination control in pharmaceutical, electronic, and other industries where ultracleanliness is important. This is a guidebook for managers, foremen, and technicians. It deals with particulate, gaseous, liquid, radiation, and microbial contamination, and describes both stationary and portable clean work stations. Laminar air flow systems are emphasized, and fundamental principles are explained.

NASA SP-5045 1967 55 pp. GPO 40 cents



A typical installation for collecting samples of particulate.

Clean Room Technology

By James W. Useller

Based on lectures given at the Lewis Research Center, this is a text for technicians in processes requiring ultracleanliness. "Some of the more valuable technology to come out of the space program appears not in 4-inch newspaper headlines but in slim little booklets like this," the editors of *Drug and Cosmetic Industry* wrote of it. "The general procedures discussed . . . in clear, concisely written detail, will be of considerable value to quality and environmental control engineers involved in pharmaceutical production."

NASA SP-5074 1969 65 pp. GPO 35 cents

NASA Contributions to Bioinstrumentation Systems

By Gershon Weltman, Moshe Klagsbrun, Donald Ukkestad, and Ben Ettelson

Proper bioinstrumentation may bring about more efficient use of the time of medical personnel. This survey of devices and techniques developed to monitor Mercury and Gemini astronauts both clarifies the problem and describes recent advances toward its solution. The authors discuss system requirements, sensors and their attachment to human beings, signal transmission and conditioning, data processing and analysis, and fabrication of bioinstrumentation. The references and bibliography make this a valuable guide for workers in the numerous disciplines involved.

NASA SP-5054 1969 97 pp.

GPO \$1.00

NASA Contributions to Cardiovascular Monitoring

This survey describes new aids to measuring blood pressure, sensing external manifestations of cardiovascular forces, and attaching electrodes to the human body. It emphasizes nonspace uses of technology developed for manned space flights. NASA SP-5041 1966

43 pp. GPO 25 cents



Signal conditioner fabrication.

Air-Pollution-Monitoring Instrumentation

By Alvin Lieberman and Peter Schipma

Thirty-two instruments and techniques developed for aerospace work were contributions to the state of the art of monitoring the atmosphere for pollution, according to these ITT Research Institute authors. This review of work done to monitor clean rooms, spacecraft cabins, and other areas covers both gas and vapor analysis and control, and particle collection and monitoring. A glossary and bibliography are included.

NASA SP-5072 1969 74 pp. GPO 40 cents

Earthquake Prediction from Laser Surveying

This report by R. A. Fowler describes a dual-beam laser system developed by North American Aviation, Inc., subsequent to a Laser Space Communications Systems Study done under contract for NASA.

NASA SP-5042 1968 32 pp. GPO 35 cents

Elastic Orifices for Gas Bearings

Test data indicate superiority of such a system over pressurized liquid and rolling-contact bearing systems.

NASA SP-5029 1965 11 pp. GPO 20 cents

Weather Satellite Picture Receiving Stations

By Charles H. Vermillion

Local weather services, radio and TV stations, scientists, farm cooperatives, and other interested persons in many different countries are now receiving cloud-cover pictures several times a day when American meteorological satellites pass overhead. This report describes an inexpensive way to construct ground equipment to receive pictures transmitted automatically from orbiting meteorological observatories. Such a station can be built from surplus parts costing less than \$500. The antenna, FM receiver, and other components are described, and the operation of such a ground station is explained for technically oriented readers. This is an enlarged and improved version of NASA SP-5079 issued in 1968; it contains chapters on a facsimile video enhancement device and a direct readout infrared system not covered previously.

NASA SP-5080 1969 83 pp. NTIS \$3.00

Joining Ceramics and Graphite to Other Materials

A Battelle Memorial Institute report covers selection of materials, joint configurations, surface preparation, and joining techniques that have made joining ceramics to metals less dependent on art. Bonding theories and ways of evaluating joints that must maintain their properties at high temperatures are discussed.

NASA SP-5052 1968 84 pp. GPO \$1.00

Method of Brazing Aluminum to Stainless Steel for High-Stress-Fatigue Applications

This short report describes a procedure for minimizing the formation of inter-metallic compounds in aluminum-stainless steel joints. Developed for valve assemblies in rocket motors, it can be adapted to making many other parts.

NASA SP-5040 1968 11 pp. GPO 15 cents

Potting Electronic Modules

This report from the Battelle Memorial Laboratories discusses and gives 115 references to recent developments in encapsulating, potting, and embedding electronic components. Embedment systems, properties of polymeric embedment materials, effects of embedment on module functioning, and production embedment procedure are among the topics discussed.

NASA SP-5077 1970 66 pp. GPO 35 cents

Contamination Control Handbook

This handbook prepared by Sandia Laboratories for Marshall Space Flight Center deals with many of the same matters discussed in SP-5045 and SP-5074. The authors' purpose in this work was to assemble in one volume as much as possible of the information and data most likely to be of practical help to persons engaged in contamination control in industrial and related operations.

NASA SP-5076 1969 385 pp. NTIS \$3.00

Visual Information Display System

This survey of display systems connected with or updated by computer-generated information deals largely with console alphanumeric and graphic devices. Subjects covered include cathode-ray tubes, man-machine reactive input devices, computer systems, and check out and control systems.

NASA SP-5049 1968 95 pp. GPO 60 cents

DEXTROUS GENERAL-PURPOSE CYBERNETIC MACHINES

Teleoperators enable men to operate tools in hostile environments without personally entering those areas. These machines are extending and amplifying men's abilities in space, the depths of the oceans, and industrial plants. The same technology can help physically handicapped persons enjoy greater mobility.

In two Special Publications, Edwin G. Johnsen, Facilities Chief of the Joint AEC-NASA Space Nuclear Propulsion Office, and William R. Corliss, a professional technical writer, have covered recent advances in teleoperator technology.

Teleoperators and Human Augmentation

Teleoperator technology has germinated and grown independently in many fields, but most of the several thousand manipulator arms built in recent years have been used in atomic energy installations. This publication traces the evolution of design principles, and discusses the interfaces between men and machines. Eight principal subsystems of today's teleoperators are described in detail.

NASA SP-5047 1968 265 pp. GPO \$1.00

Teleoperator Controls

This sequel to NASA SP-5047 emphasizes controls of the machines that are helping to "hybridize man and machine." Coupled with advances in several sciences, Glenn T. Seaborg writes in the Foreword, teleoperators "will hopefully propel us toward a new society in which man can at last have time and resources to think and act in new directions and new dimensions."

NASA SP-5070 1969 162 pp. NTIS \$3.00

Advancements in Teleoperator Systems

Proceedings of a colloquium at the University of Denver in February 1969 on current and possible uses of teleoperator technology.

NASA SP-5081 1970 236 pp. NTIS \$3.00

Assessing Technology Transfer

By Richard L. Lesher and George J. Howick

An abridgement of a report prepared for the National Commission on Technology, Automation, and Economic Progress, which was established in August 1964. Considered are such questions as the value of technology transfer as a national goal, the sufficiency of sources for such transfer, incentives and barriers, transfer mechanisms or channels used to date, and elements essential to effective transfer.

NASA SP-5067 1966 121 pp. GPO 50 cents

Applications of Systems Analysis Models

This survey is addressed primarily to managers outside the aerospace industry who may benefit from an understanding of new management techniques that NASA has helped to develop. It describes mathematical models and systems analysis technology applicable to a wide range of large-scale complex undertakings in both the public and the private sectors of the economy. It discusses in particular the application of such technology to urban and regional planning.

NASA SP-5048 1968 69 pp. GPO 50 cents

NASA Contributions to the Development of Special-Purpose Thermocouples

By C. Eugene Moeller, Michael Noland, and B. L. Rhodes

Applications of thermocouples to increase accuracy and reduce costs in a multitude of industries are suggested by this survey of new thermocouples and techniques of using them developed to meet NASA's varied and stringent needs. The developments described include thermocouples for cryogenic use and for measuring temperatures above 3000° F. The survey covers special probes for measuring gas temperatures, the temperatures of solids, and surface temperatures, and explains their use in energy-transfer gauges. NASA SP-5050 1968 94 pp. GPO \$1.25

Adhesives, Sealants, and Gaskets

By R. B. Perkins and S. N. Glarum

A survey of adhesives, sealants, and gaskets developed to operate in the extreme environment of space that will interest specialists in the subject. The reliability of materials used in a liquid oxygen environment is emphasized. The following are described in detail: polymeric fillers in adhesives, elastomeric films in glue lines, epoxy ester adhesives, sealants for low-temperature service, gasket design, and measurement of stress in gaskets. NASA SP-5066 1967 63 pp. GPO 25 cents

Plasma Jet Technology

Compiled by P. R. Dennis, C. R. Smith, D. W. Gates, and J. B. Bond

This survey emphasizes the industrial potential of plasma generators in the testing, coating, and spraying of materials, in chemical synthesis, and in other industrial operations. It includes accounts of NASA contributions to such technology and the instrumentation involved. NASA SP-5033 1965 200 pp. GPO \$1.00

Precipitation-Hardening Stainless Steels

Steels that resist corrosion and have high strength at high temperatures have figured importantly in the work of both the Atomic Energy Commission and NASA. Information regarding their use is now available in seven reports, originally prepared by the Battelle Memorial Institute for the George C. Marshall Space Flight Center, and revised and updated by the authors for publication in 1968.

Each report may be ordered from the National Technical Information Service for \$3. Titles, authors, and numbers are:

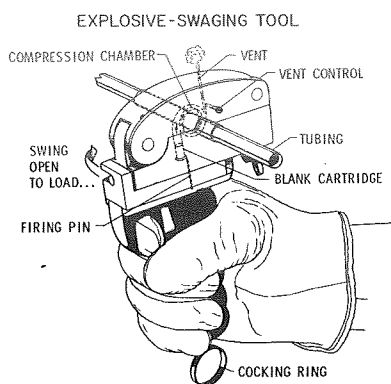
Machining and Grinding of Ultrahigh-Strength Steels and Stainless Steel Alloys, C. T. Olofson, J. A. Gurklis, and F. W. Boulger, 202 pp., NASA SP-5084; Adhesive Bonding of Stainless Steels—Including Precipitation-Hardening Stainless Steels, R. E. Keith, M. D. Randall, and D. C. Martin, 115 pp., NASA SP-5085; Shaping of Precipitation-Hardening Stainless Steels by Casting and Powder Metallurgy, J. G. Kura, V. D. Barth, and H. O. McIntire, 42 pp., NASA SP-5086; Welding of Precipitation-Hardening Stainless Steels, by J. J. Vagi, R. M. Evans, and D. C. Martin, 181 pp., NASA SP-5087; Deformation Processing of Precipitation-Hardening Stainless Steels, by D. E. Strohecker, A. F. Gerds, and F. W. Boulger, 256 pp., NASA SP-5088; Thermal and Mechanical Treatment for Precipitation-Hardening Stainless Steels, by C. J. Slunder, A. F. Hoenie, and A. M. Hall, 193 pp., NASA SP-5088; Surface Treatments for Precipitation-Hardening Stainless Steels, by A. M. Hall, 56 pp., NASA SP-5090.

SYMPOSIA ON AVAILABLE NEW TECHNOLOGY

Aerospace Related Technology for Industry

NASA work on which small businesses may capitalize was stressed at a May 1969 conference at Langley Research Center. Speakers explained services available from NASA, cited examples of technology transfers, and described new devices such as the swagging tool shown at the right. This volume of proceedings also covers advances in electronics, materials, and shop and production operations. NASA SP-5075 1969

183 pp. NTIS \$3.00



Selected Technology for the Electric Power Industry

Proceedings of a Lewis Research Center conference in September 1968 at which papers were presented on nuclear reactor heat sources, Rankine cycle power systems, Brayton cycle systems, direct energy conversion, superconductivity, and other topics of concern in the generation of electrical power, including: Reliability, instrumentation, automatic checkout and control, materials, bearings, and seals. NASA SP-5057 1968 321 pp. NTIS \$3.00

Nondestructive Testing: Trends and Techniques

The proceedings of the Second Technology Status and Trends Symposium, in October 1966, at the Marshall Space Flight Center. Technical papers discuss the examination of multilayer printed wiring boards by laminography, evaluation of adhesive bonded composite materials, ultrasonic analysis of aluminum, and X-ray television techniques for nondestructive testing. The nine papers in this newsy publication are highly illustrated. NASA SP-5082 1967 123 pp. GPO 55 cents

Conference on Selected Technology for the Petroleum Industry

A conference held at Lewis Research Center, December 8-9, 1965, to acquaint representatives of the petroleum industry with new technology resulting from the space effort. Choice of the topics was guided by a series of meetings between Lewis staff members and petroleum specialists. Those topics included combustion, heat transfer, surface physics, magnetics, pumps, lubricants, bearings, and seals.

NASA SP-5053 1966 169 pp. GPO \$1.25

Symposium on Technology Status and Trends

Proceedings of a conference at Huntsville, Ala., April 21-23, 1965, sponsored by the Technology Utilization Office of Marshall Space Flight Center for representatives of nonaerospace industry. NASA SP-5030 1966 248 pp. GPO \$1.50

Analytical Chemistry Instrumentation: A Survey

By Julia S. Whittick, R. F. Muraco, and Leonard A. Cavanagh

The alpha-scattering device used on the Moon for chemical analysis of its surface is one of many intriguing instruments described in this survey by Stanford Research Institute scientists. NASA contributions to ultraviolet, infrared, and X-ray spectroscopy, neutron-activation analysis, mass spectroscopy, gas chromatography, specific gas analyzers, vacuum equipment, and life-detection techniques are reviewed. "This book will attract lively interest among many scientists, technicians, and managers from the most varied fields," the reviewer of it wrote in the February 1969 issue of *Applied Optics*.

NASA SP-5083 1967 134 pp. GPO 60 cents

Thermal Insulation Systems: A Survey

By Peter E. Glaser et al.

Aerospace work helpful to designers of such varied things as natural gas pipelines and surgical tools is reviewed in this survey by an internationally noted authority on solar furnaces and his colleagues at Arthur D. Little, Inc. Fundamental principles and measurement methods are discussed, as well as placement of insulation materials, the structure of multilayer systems, and supports for insulation.

NASA SP-5027 1967 148 pp. GPO 60 cents

Commercial Potentials of Semipermeable Membranes

By Sidney B. Tuwiner, Ernest J. Henley, and H. Kenneth Staffin

A survey of spacecraft-stimulated progress in producing and using membranes, including advances which have varied but impressive economic potentialities. Presented are data on new techniques and principles, membrane applications in batteries, advances in material science, level control in batteries, fuel cells, and various separation processes.

NASA SP-5061 1967 45 pp. GPO 35 cents

Magnetic Tape Recording

By Skipwith W. Athey

A survey of the entire range of recorder technology, with emphasis on two aspects of development in which NASA has played an important part. One is the area of miniature severe-environment tape recorders, for use in satellites and space probes. The other area is that of commercial, ground-based tape recorders.

NASA SP-5038 1966 326 pp. GPO \$1.25

The Electromagnetic Hammer

This report describes a method of using a pancake electromagnetic coil driven by electric-discharge equipment to smooth out nonferrous metal components such as welded rocket fuel tanks, gore segments, and bulkheads.

NASA SP-5034 1965 22 pp. GPO 25 cents

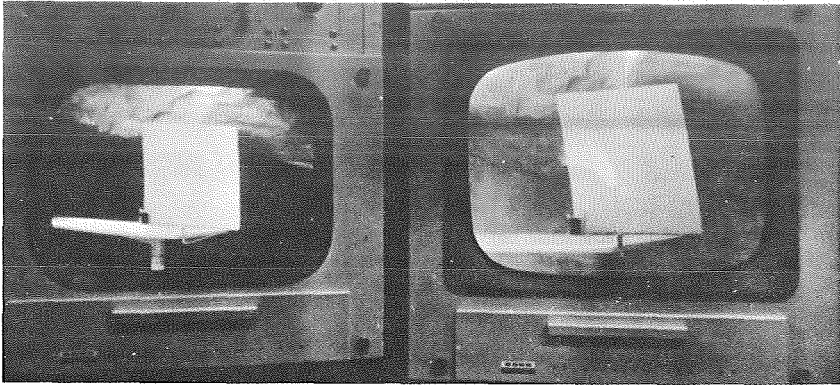
Precision Tooling Techniques

Describes devices with possible industrial applications, developed at NASA's Marshall Space Flight Center.

NASA SP-5013 1964 25 pp. GPO 25 cents

Hydrogen Leak and Fire Detection

By B. Rosen, V. H. Dayan, and R. L. Proffit



Infrared TV (right) shows hydrogen diffusion flame clearer than conventional TV.

Experiences and needs of typical producers and users of hydrogen are discussed and present leak and fire detection technology is evaluated in this survey undertaken by North American Rockwell's Rocketdyne Division for NASA. The booklet includes a critical evaluation of the applicable literature, and recommendations for further research and development in this field.

NASA SP-5092 1970 83 pp. GPO 45 cents

A New Aluminum Sand Casting Alloy of High Toughness (M-45)

By R. A. Wood

This report describes a new alloy consisting mainly of aluminum admixed with copper, cadmium, magnesium, and titanium, designed for use in cryogenic environments where strength, ductility, and toughness are required.

NASA SP-5091 1970 36 pp. GPO 40 cents

Flat Conductor Cable Technology

Flat conductor cable is often more compatible with modern circuit designs than round wire. Marshall Space Flight Center has been active in developing flat conductor cable technology for a dozen years to save weight and increase reliability. This report presents technical information for engineers considering its use.

NASA SP-5043 1968 49 pp. GPO 40 cents

Selected Electronic Circuitry

Describes specific innovations derived from space programs that appear to be useful generally. Information is included on amplifier, oscillator, multivibrator, wave-shaping, temperature-compensation, and control circuits. Special computer circuits are also included.

NASA SP-5046 1967 100 pp. GPO 70 cents

Welding for Electronic Assemblies

This handbook covers the theory, requirements, and fundamental techniques of interconnecting electronic components by resistance spot welding.

NASA SP-5011 1964 81 pp. GPO 40 cents

Structural Design Concepts: Some NASA Contributions

By L. Albert Scipio

Many aerospace contributions to structural design are applicable to buildings and other structures that need not fly. The author of this survey has summarized such advances in structural types, concepts, and design synthesis and optimization. He describes the development of materials associated with these advances, and gives examples of ways in which they may be used. This survey was written primarily for the designer and is being used as a college text. Eighty-one figures, scores of references, and a glossary are included.

NASA SP-5039 1967 174 pp. GPO 70 cents

Advanced Valve Technology

By Louis C. Burmeister, John B. Loser, and Eldon Sneegas

This is a second, greatly enlarged, and improved edition of a Midwest Research Institute survey of innovations that are helping to solve leakage, thermal, and reliability problems in a variety of fluid systems. It discusses materials compatibility, lubrication, and response time; valve actuators, position indicators, and computer control.

NASA SP-5019 1967 183 pp. GPO \$1.00

Solid Lubricants

By M. E. Campbell, John B. Loser, and Eldon Sneegas

A survey of the state of development of solid lubricants, including types and specifications, commercial applicability, cost factors, theory, and new developments in the field. Methods of evaluating solid-film lubricants and the test apparatus are also discussed.

NASA SP-5059 1966 115 pp. GPO 50 cents

A "Bibliography on Solid Lubricants" also has been published as NASA SP-5037 (1966 14 pp. NTIS \$3.00).

NASA Contributions to the Technology of Inorganic Coatings

By Jerry D. Plunkett

A survey of NASA's contributions in the areas of thermophototropic coatings, thermal control for space vehicles, solid-lubrication coatings, thermal-insulation coatings, application of coatings to substrates, and measurement of coating optical properties, and refractory metal oxidation-resistant coatings.

NASA SP-5014 1964 268 pp. GPO \$1.00

Soldering Electrical Connections, 4th Edition

Prepared under the direction of James A. Gay, Jr.

Diagrams, photographs, and detailed instructions covering dependable techniques for making different kinds of electrical connections.

NASA SP-5002 1967 66 pp. GPO 30 cents

NASA Contributions to Metals Joining

By W. J. Reichenacker and J. Heuschkel

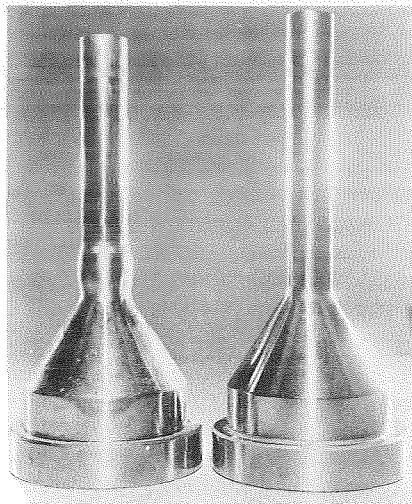
This survey covers the many developments in joining metals by mechanical fasteners, soldering, brazing, welding, and plasma spray bonding, reported between 1962 and mid-1965.

NASA SP-5064 1967 141 pp. GPO 60 cents

The Metallurgy, Behavior and Application of the 18 Percent Nickel Maraging Steels

By A. M. Hall and C. J. Slunder

The structural strength and fracture toughness of 18 percent maraging steels, first announced in 1959, have prompted the use of these steels in industrial equipment, naval vessels, and aircraft. This survey of users and manufacturers summarizes and brings together compactly much of the available literature regarding the extraordinary properties and the potentialities of these steels. Dozens of tables and figures, 182 references, and a bibliography make this work by Battelle Memorial Institute specialists a handy guide for engineers, designers, and students.



Deformed tool steel extrusion ram (left) and a maraging steel replacement (right).

NASA SP-5051 1969 137 pp. GPO \$1.50

Application of Biogeochemistry to Mineral Prospecting

The relationships found between biological species and minerals, and the potentialities of remote sensing of the environment, are dealt with in this survey by personnel of the Rocketdyne Division of North American Rockwell Corp. Theoretical concepts are presented and possibilities of applying observations from high altitudes to prospecting for mankind's benefit are discussed.

NASA SP-5056 1968 135 pp. NTIS \$3.00

Induction Heating Advances: Applications to 5800° F

By A. F. Leatherman and D. E. Stutz

Complex objects are routinely brazed in a versatile and practical induction heating furnace designed at Lewis Research Center. In other Lewis furnaces, solid materials have been induction heated to above 5800° F. Specialists at Battelle Memorial Institute wrote this report, added an appendix reviewing basic principles of induction heating, and listed further sources of information about it.

NASA SP-5071 1969 41 pp. GPO 30 cents

Microelectronics in Space Research

Provides information on the contributions to the microelectronics field that have originated in NASA research programs. Also includes a review of the status of microelectronics, in which the limitations of the various technologies are highlighted.

NASA SP-5031 1965 130 pp. GPO 60 cents

Vacuum Switchgear

By W. S. Emmerich

Technological advances in space work have increased the possibility of operating electrical switches in vacuum.

NASA SP-5063 1964 36 pp. GPO 35 cents

Effects of Low Temperatures on the Mechanical Properties of Structural Metals

By H. L. Martin, P. C. Miller, A. G. Imgram, and J. E. Campbell

This is a revised and enlarged edition of NASA SP-5012 (same title, 55 pp. GPO 40 cents) issued in 1964. It includes advances in the field since then, and contains data helpful to persons interested in gas liquefaction and separation, the storage and handling of cryogenic fluids, low-temperature heat exchange, quick freezing, superconductivity, and low temperature surgery.

NASA SP-5012(01) 1968 65 pp. GPO 50 cents

High-Velocity Metalworking

By M. C. Noland, H. M. Gadberry, J. B. Loser, and E. C. Sneegas

This is a comprehensive survey by the Midwest Research Institute of the new state of the arts of electromagnetic, electrohydraulic, pneumatic-mechanical, and explosive metalworking. By these processes, complex, finished surfaces, and close-tolerance parts in a great range of sizes can now be produced with less waste than by more conventional methods. The authors explain the fundamentals, point out the limitations, and emphasize the varied potentialities of all four processes. Separate chapters cover die design and material behavior at high strain rates. There are 290 illustrations and 192 references. NASA SP-5062 1967 183 pp. GPO \$1.50

Pavement Grooving and Traction Studies

The proceedings of a conference held at Langley Research Center, November 18 and 19, 1968, includes 27 papers presented by various participating governmental and civil organizations engaged in a research program concerning aircraft operations on wet runways. Sessions on Aircraft Operational Problems, Aircraft Performance, Recent Skid Correlation Studies, and Surface Treatments To Improve Tire Traction on Highways are included. Scores of persons have found this review of traction research helpful in efforts to reduce highway fatalities.

NASA SP-5073 1969 512 pp. NTIS \$3.00

Technical and Economic Status of Magnesium-Lithium Alloys

By Paul D. Frost

Magnesium-lithium alloys, their general characteristics, current applications, and economic considerations are briefly reviewed. One objective is to report on the progress being made in the application of the new ultralight magnesium-lithium alloys in the space industry and to disseminate this information to those organizations not acquainted with the alloys and their applications. The second objective is to speculate on possible future usefulness of the alloys and to define technical and economic requirements for commercial use. NASA SP-5028 1965 45 pp. GPO 25 cents

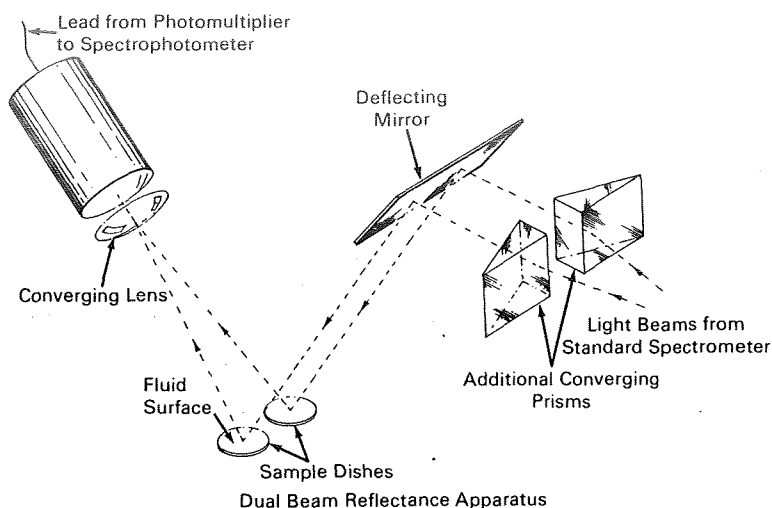
Properties and Current Applications of Magnesium-Lithium Alloys

By R. J. Jackson and P. D. Frost

This is a compilation of engineering information on magnesium-lithium alloys. The mechanical properties and metallurgical characteristics for standard and developmental alloys are included. Various processing techniques, including cleaning and finishing, fabrication, casting, and joining, are discussed.

NASA SP-5068 1967 54 pp. GPO 40 cents

Concise Announcements



A way to tell mineral oil slicks from fish oil.

A NASA Tech Brief is a one- or two-page announcement. Many of these briefs simply state a specific problem, a solution, and a source of additional information. Others notify readers of the availability of new concepts, hardware, and software resulting from NASA research and development activities.

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Cumulative Index to NASA Tech Briefs, 1963-1969

NASA SP-5021(10) 1970 1112 pp. NTIS \$10.00

NASA Contributions to Fluid-Film Lubrication

By H. C. Rippel, Otto Decker, and Z. Zudans

Space exploration has been a driving force in advances in fluid-film lubrication, these Franklin Research Institute authors show in this illustrated, technical account of the new state of the art. The applications described range from those in precision-guidance apparatus aboard spacecraft to the support of the 80-foot-diameter antennas that track deep-space probes. The coverage includes incompressible and compressible hydrostatic and hydrodynamic lubrication and squeeze-film lubrication. A glossary adds to this work's value as a text.

NASA SP-5058 1969 196 pp. GPO \$2.00

Nonglassy Inorganic Fibers and Composites

By Cameron G. Harman

This report presents information about non-metallic, inorganic whiskers and fibers, and composites that may be useful to industry. Emphasis is given to boron carbide whiskers, boron filaments, refractory ceramic fibers, and metal-fiber-reinforced metallic composites. This is a Southwest Research Institute report with 61 references.

NASA SP-5055 1966 44 pp. GPO 35 cents

Tungsten Powder Metallurgy

By V. D. Barth and H. O. McIntire

Prepared for NASA under contract by Battelle Memorial Institute, this report summarizes recent developments in tungsten-powder metallurgy technology as related to space vehicles and the less traditional applications. The customary use of tungsten as a carbide or as a minor alloying element is not considered.

NASA SP-5035 1965 40 pp. GPO 35 cents

Metal-Forming Techniques

By Ilia I. Islamoff

Outlines recent metal-forming methods for sheet and plate materials used by the aircraft and aerospace industries, and describes particularly the techniques employed at present, some of which, like magnetic forming and hot-drape forming, are in experimental stages.

NASA SP-5017 1965 52 pp. GPO 40 cents

Mathematical Computer Programs

Several mathematical programs and programing techniques for digital computers which are available through the NASA Technology Utilization program are outlined. Although the functions that the programs perform are not new, and similar programs are available in many large computer center libraries, the collection may be useful to centers with limited systems libraries for instructional purposes for new computer operators.

NASA SP-5069 1967 26 pp. NTIS \$1.00

Some New Metal and Metal-Ceramic Composites

This report is designed to show industrial management the current state of development of some composite materials, including dispersion-strengthened composites, fiber composites, and reinforced ceramics.

NASA SP-5060 1966 26 pp. GPO 25 cents

Histories and Chronologies

Adventures in Research:

A History of the Ames Research Center, 1940-1965



The Bell X-14A VTOL aircraft undergoing tests at Ames.

Dedicated to Dr. Smith J. DeFrance, who directed the Ames Research Center for its first quarter of a century, this is a generously illustrated account of the California laboratory's response to the need for aeronautical advances in World War II and the subsequent requirements for space missions. The author stresses challenges met in both periods, reviews the laboratory's growth, and cites both technological and managerial achievements.

NASA SP-4302 1970 576 pp. GPO \$4.75

The Apollo Spacecraft: A Chronology

By Ivan D. Ertel and Mary Louise Morse

This is the first of several volumes in which the concept, design, and development of the Apollo spacecraft will be recorded. Events prior to November 1962 are listed here, beginning with Hermann Oberth's suggestion in 1923 that a circum-lunar flight be made. Sponsored by the NASA Manned Spacecraft Center at Houston, it includes a glossary of abbreviations, organization charts, and other appendices.

NASA SP-4009 1969 269 pp. GPO \$2.50

Project Gemini: A Chronology

By James M. Grimwood and Barton C. Hacker with Peter J. Vorzimmer

Intended both to stand as an independent work and to provide a foundation for a narrative history of the U.S. second manned space-flight program, this chronology is fully documented and comprehensively indexed.

NASA SP-4002 1969 308 pp. GPO \$2.75

Venture Into Space: Early Years of Goddard Space Flight Center

By *Alfred Rosenthal*

The origins, traditions, projects and activities of NASA's Goddard Space Flight Center are recorded in this preliminary history, including the early organization, budget, personnel, and programs. Topics stressed include weather and communication satellites, and tracking and data processing.

NASA SP-4301 1968 354 pp. GPO \$2.50

An Administrative History of NASA, 1958-1963

By *Robert L. Rosholt, with a Foreword by James E. Webb*

The first five chapters of this study cover the antecedents and first years of the National Aeronautics and Space Administration; the remaining four deal with the change in political administration and the acceleration of the space program in 1961, and with the organizational consequences through 1963.

NASA SP-4101 1966 381 pp. GPO \$4.00

This New Ocean: A History of the Project Mercury

By *Lloyd S. Swenson, Jr., James M. Grimwood, and Charles C. Alexander*

A highly readable, well-documented story of Project Mercury, the first U.S. manned space flight program, which spanned 55 months from authorization through Cooper's 22-orbit flight in May 1963, and which involved more than 2 million people.

NASA SP-4201 1966 680 pp. GPO \$5.50

Space Medicine in Project Mercury

By *Mae Mills Link*

This volume examines the development of NASA's fund of space-medicine information and experience. It also shows how NASA was able to draw upon the vast and rich resources of the Air Force, the Navy, other Government agencies, industry, and research institutions.

NASA SP-4003 1965 198 pp. GPO \$1.00

Project Mercury: A Chronology

By *James M. Grimwood*

A listing of major events in the first U.S. manned space-flight program, from preliminary talks to May 1963.

NASA SP-4001 1963 283 pp. GPO \$1.50

Astronautics and Aeronautics, 1968 Chronology on Science, Technology, and Policy

Events, statements, and other information pertinent to aeronautical and space affairs compiled for ready reference. Sources include newspapers, speeches, agency releases, and magazine articles.

NASA SP-4010 1969 429 pp. GPO \$2.00

Under the same title similar chronologies are available for five preceding years.

For 1967, NASA SP-4008 1968 429 pp. GPO \$2.25

For 1966, NASA SP-4007 1967 479 pp. GPO \$1.50

For 1965, NASA SP-4006 1966 681 pp. GPO \$2.25

For 1964, NASA SP-4005 1965 527 pp. GPO \$1.75

For 1963, NASA SP-4004 1964 610 pp. GPO \$2.00

Management, Evaluation, and Analysis Standards

An Introduction to the Evaluation of Reliability Programs

By D. S. Liberman and A. J. Slechter

A basic orientation to the task of evaluating the effectiveness of a reliability program is presented. Primary emphasis is devoted to discussing the assurance task as it relates to project requirements and resources, and to describing the factors which determine effectiveness in program implementation. Although intended mainly for NASA personnel, this and other monographs in this category are generic in their applicability.

NASA SP-6501 1967 67 pp. NTIS \$3.00

Elements of Design Review for Space Systems

To help technically trained personnel implement and evaluate a design review program, this publication discusses the objectives, elements, application, and costs. Functions the design review should serve at various levels of assembly, milestones in development, and on differing projects are set forth.

NASA SP-6502 1967 57 pp. NTIS \$3.00

Introduction to the Derivation of Mission Requirements Profiles for Systems Elements

From the mission requirements profile for an overall system, requirement profiles for subsystems can be derived by identifying the relating parameters and resolving their influence numerically. This document describes a 10-step process. Appendices illustrate its use to derive requirement profiles for six subsystems of spacecraft.

NASA SP-6503 1968 91 pp. NTIS \$3.00

Failure Reporting and Management Techniques in the Surveyor Program

"Many of the innovations employed on Surveyor may prove useful in the management of other complex development programs," according to Benjamin Milwitzky, Surveyor Program Manager, NASA Headquarters. This document describes the rigorous, closed-loop failure reporting system that functioned as an effective mission-assurance tool.

NASA SP-6504 1967 46 pp. NTIS \$3.00

Parts and Materials Application Review for Space Systems

Parts and materials application reviews attest to the adequacy of space system hardware. This is a guide for parts and materials specialists and design engineers. It describes NASA's parts and materials program, discusses the structuring of the application review, and gives examples of appropriate activities.

NASA SP-6505 1967 53 pp. NTIS \$3.00

Introduction to the Assurance of Human Performance in Space Systems

For project engineering and management personnel, this is a guide to methods of detecting and eliminating human-induced failures. Design features, procedures, and work situations are considered.

NASA SP-6506 1968 42 pp. NTIS \$3.00

Weight/Performance Management Survey Manual

An Apollo Program Office Manual providing procedures for a management assessment of contractor activities, performance, and effectiveness of the management system.

NASA SP-6006 1965 31 pp. NTIS \$3.00

Electrical Power Management Survey Manual

Procedures for a management audit of NASA Apollo Program contractor activities. It assesses performance toward objectives, evaluates effectiveness of the management system, and, where weaknesses exist, provides a tool for determining corrective action.

NASA SP-6007 1965 31 pp. NTIS \$3.00

Electrical Power Management Standard

This document is a standard for all Apollo procurement actions. It establishes a system for the management and reporting of electrical power source, load, and distribution properties of space vehicles.

NASA SP-6005 1965 31 pp. NTIS \$3.00

Mass Properties Standard

This publication establishes a system for the management of mass properties during procurement and use of space vehicles, or portions thereof.

NASA SP-6004 1965 88 pp. NTIS \$3.00

Reliability Program Evaluation Procedures

The objectives of this document are (1) to establish uniform standards for evaluating the degree and effectiveness of reliability practices and controls; (2) to identify reliability problems for evaluation and correction; (3) to permit evaluation of the various methods of controlling a specific area leading to improved reliability and safety levels.

NASA SP-6002 1963 52 pp. NTIS \$3.00

Quality Program Evaluation Procedures

Procedures and related survey checklists to be used in evaluating quality procedures and controls being applied to manned spaceflight programs are set forth.

NASA SP-6003 1963 69 pp. NTIS \$3.00

Structural Systems and Program Decisions

Two volumes written for decision-makers who must assimilate, validate, and interpret changes in baseline requirements on vehicle programs. This study presents a computer program designed to help management rapidly assess the impact of design criteria. These volumes were prepared by the Apollo Program Office to explain and stimulate interest in the art and science of real-life forecasting.

Vol. 1 NASA SP-6008 1966 214 pp. NTIS \$3.00

Vol. 2 NASA SP-6008(01) 1966 386 pp. NTIS \$3.00

Forecasts and Appraisals for Management Evaluation

Two volumes intended primarily for those responsible for the administration, design, development, manufacture, and test of the Apollo system.

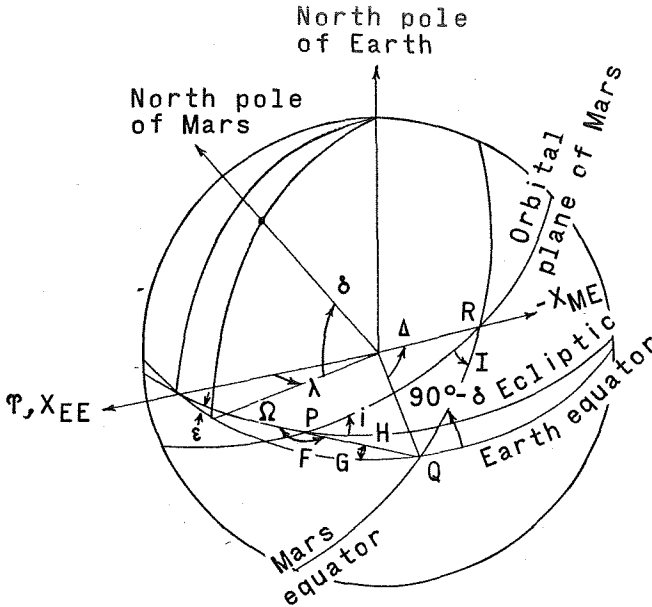
Vol. 1 NASA SP-6009 1966 220 pp. NTIS \$3.00

Vol. 2 NASA SP-6009(01) 1966 370 pp. NTIS \$3.00

Handbooks, Data Compilations, Charts, and Tables

Relative Geometries of the Earth, Sun, and Mars From the Year 1973 to the Year 2000

By Sue W. Souders



Transformation from geocentric to areocentric equatorial system.

Calculated relative geometries of the Earth, Sun, and Mars at 10-day intervals are presented in this Langley Research Center work with sufficient accuracy for mission planning. Parameters include the latitude and longitude of Mars and Earth in the heliocentric coordinate system; the right ascension and declination of the Earth, Sun, and Canopus in the areocentric system; and radial distances and angles in the Sun-Earth-Mars triangle. Data are presented in both tabulated and graphical form to facilitate the solution of complex problems with many parameters.

NASA SP-3053 1970 128 pp. NTIS \$3.00

Space Materials Handbook

By John B. Rittenhouse and John B. Singletary

This is a revised, updated, third edition of a Lockheed Palo Alto Research Laboratory handbook presented in four parts: The space environment, its effect on materials, materials in space, and biological interaction with spacecraft materials. Information on mechanical, physical, and chemical properties of a wide variety of metallic and nonmetallic materials is given. Categories include structural materials, electronic components, thermal control materials, adhesives, seals, and lubricants.

NASA SP-3051 1970 734 pp. NTIS \$3.00

A Ray-Tracing Digital Computer Program for the Study of Magnetospheric Duct Propagation

By Jayaram Ramasastry and Edward J. Walsh

The computer program discussed was used to conduct ray tracing of electromagnetic waves in the magnetosphere. Information necessary for a nonprogrammer to run the program is included, and a manual describes the program structure. The program was designed to operate in the IBM 7094 IBSYS environment. It is written in Fortran IV but utilizes a MAP assembler subroutine to integrate the differential equations.

NASA SP-3055 1970 304 pp. NTIS \$3.00

Semiclassical Elastic Scattering Cross Sections for a Central Field Potential Function

By James R. Stallcop

It is often necessary to evaluate the differential elastic scattering cross section for a given interaction potential when calculating dynamic properties of a collection of atoms and molecules, or in the analysis of measured cross sections to determine potential energy. This book outlines the development and application of a semiclassical scattering approximation to the partial-wave description. Computed quantities are given in tables.

NASA SP-3052 1969 296 pp. NTIS \$3.00

Two-Micron Sky Survey: A Preliminary Catalog

Prepared by G. Neugebauer and R. B. Leighton

Sources of emission in the 2.2 region are given for more than 5,000 stars. The California Institute of Technology began an infrared sky survey in 1965 to obtain an unbiased sample of celestial objects that emit in the infrared region and to study their characteristics. The findings presented in this catalog are expected to be helpful to astronomers throughout the world.

NASA SP-3047 1969 322 pp. NTIS \$3.00

Tabulations of Configuration Factors Between Any Two Spheres and Their Parts

By Norman T. Grier

Tables of values of the configuration factors between two spheres, between parts of one sphere and parts of another sphere, and between a point on one sphere and parts of another sphere, are presented. Conditions corresponding to the Earth-Moon situation are included in the calculations.

NASA SP-3050 1969 420 pp. NTIS \$3.00

Computer-Aided Filter Design Manual

By Sidney Gussow and Glenn Weathers

To meet a need in communications and telemetry for a simple, accurate method of filter design and synthesis, the Space Support Division of Sperry Rand developed a computerized technique described in this report. Charts, examples, programs, and subroutines are included. Both inexperienced and experienced designers may find this technique helpful.

NASA SP-3049 1969 101 pp. GPO \$1.25

Venus and Mars Nominal Natural Environment for Advanced Manned Planetary Mission Programs, 2d Edition

By Dallas E. Evans, David E. Pitts, and Gary L. Kraus

Numerical values for a nominal natural environment for application in studies of advanced planetary missions to Venus and Mars. The data compiled here provide a standard environment so that various mission and preliminary design studies will be based on realistic data and have a common basis for comparison of end results. The data in this revised edition differ from those of the first edition mainly as a result of the Mariner IV Mars flyby experimental results.

NASA SP-3016 1967 52 pp. NTIS \$3.00

Thermodynamic Equilibrium in Prebiological Atmospheres of C, H, O, N, P, S, and Cl

By M. O. Dayhoff, E. R. Lippincott, R. V. Eck, and G. Nagarajan

The book presents the mathematical methods used and the computer program from which the tables were derived. Also, a survey of thermodynamic equilibrium states of ideal gas systems containing C, H, O, N, P, S, and Cl are discussed. Appendix I discusses applications with regard to the thermodynamic equilibria in planetary atmospheres. Appendix II discusses application with regard to the role of thermodynamic equilibrium in the inorganic origin of organic matter.

NASA SP-3040 1967 257 pp. NTIS \$3.00

Handbook of the Physical Properties of the Planet Venus

By L. R. Koenig, F. W. Murray, C. M. Michaux, and H. A. Hyatt

Radio and radar astronomy, and the flight of Mariner II, have added observational data to theoretical studies of Venus, the nearest planet to Earth. This volume reviews what is known of its surface, atmosphere, and other still bewildering properties.

NASA SP-3029 1967 132 pp. GPO 60 cents

Handbook of the Physical Properties of the Planet Mars

By C. M. Michaux

Although observed from Earth at every opportunity for many years, Mars remains an enigma. This volume summarizes both observational and theoretical conclusions. (See also Mariner-Mars reports listed on p. 2.)

NASA SP-3030 1967 167 pp. GPO 70 cents

Handbook of the Physical Properties of the Planet Jupiter

By C. M. Michaux et al.

The largest planet in the solar system is especially intriguing because of such difficult-to-explain features as its wandering Great Red Spot and erratic decameter radio noise storms. More difficult to approach than Mars or Venus, Jupiter will be the next planet examined from spacecraft.

NASA SP-3031 1967 142 pp. GPO 60 cents

Compressed Gas Handbook

Edited by John S. Kunkle, Samuel D. Wilson, and Richard A. Cota

Theory and data required to analyze high-pressure compressible flow systems used in space vehicle ground support equipment are presented in this handbook.

NASA SP-3045 1969 560 pp. GPO \$4.75

Models of the Trapped Radiation Environment:

Vol. I: Inner Zone Protons and Electrons

By James I. Vette

Vol. II: Inner and Outer Zone Electrons

By James I. Vette, Antonio B. Lucero, and Jon A. Wright

Vol. III: Electrons at Synchronous Altitudes

By James I. Vette and Antonio B. Lucero

Vol. IV: Low Energy Protons:

By Joseph H. King

Vol. V: Inner Belt Protons:

By James P. Lavine and James I. Vette

Vol. VI: High Energy Protons:

By James P. Lavine and James I. Vette

These volumes are compilations of the results of a program sponsored by NASA and USAF for the purpose of defining a model of the radiation environment of the Earth. The first two volumes contain model environments for the lower altitude regions where trapping is relatively stable. The third volume presents a model of the Earth synchronous orbit at 19,300 nautical miles near the boundary of stable trapping where the particle fluxes vary through several orders of magnitude. The fourth volume contains a model of the energy proton flux for energies below 4 MeV. Volume V updates information in Volume I.

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By Jerry M. Allen and Dorothy H. Tudor

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Compiled by E. A. Mechtly

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Subject Index

A

Abstracts, 43
Acceleration tolerance, 20
Adhesives, 26
Aerodynamic drag, 10
Aerodynamic forces, 10
Aerodynamic noise, 10
Aerodynamics, 19
Aeronautical engineering, 35
Aeronautics, 36
Aerospace engineering, 11, 36, 43
Aerospace environments, 20, 26, 39
Aerospace industry, 34, 35
Aerospace medicine, 23, 36, 43
Aerospace sciences, 19-21
Aerospace systems, 17, 19, 21, 27, 37
Air pollution, 23
Aircraft configurations, 10
Aircraft engines, 10
Aircraft instruments, 14
Aircraft performance, 32
Alloys, 14, 32
Aluminum, 24
Aluminum alloys, 29
Analysis (mathematics), 8
Apollo flights, 3
Apollo Lunar Surface Experiments Package, 3
Apollo project, 38
Apollo spacecraft, 35
Ariel 1 satellite, 21
Assurance, 37
Astronautics, 36
Astronomical photography, 4
Astronomy, 3, 19, 21
Astrophysics, 14
Atmospheric chemistry, 41
Atmospheric radiation, 18
Atmospheric turbulence, 9
Attitude indicators, 16
Automatic control, 9
Automatic Picture Transmission, 24

B

Bibliographies, 43
Biochemical fuel cells, 12
Biochemistry, 6
Biogeochemistry, 31
Bioinstrumentation, 23, 25
Biological effects, 43
Biosynthesis, 18
Blood pressure, 23
Bones, 18
Boundary-layer flow, 10
Brazing, 24

C

Carbon dioxide, 6
Cardiovascular system, 23
Catalogs (publications), 43
Cathode ray tubes, 24
Celestial bodies, 40
Ceramic bonding, 24
Ceramics, 34
Channels (data transmission), 25
Chemical analysis, 28
Chronology, 35, 36
Circuit protection, 8
Circuits, 29
Clean rooms, 22
Cloud cover, 7
Cloud seeding, 10
Color photography, 7
Comets, 4
Command guidance, 16
Composite materials, 11, 30, 34
Compressible boundary layer, 10
Compressible flow, 41
Computer components, 29
Computer programs, 34, 38, 40
Computerized design, 24, 40
Computerized simulation, 18
Conferences, 3-6, 8-16, 18, 20, 21, 25, 27, 32
Constants, 44
Contamination, 21, 22, 24
Contractors, 44
Controlled atmospheres, 22
Conversion tables, 44
Cosmic rays, 13
Critical flow, 42
Crude oil, 27
Cryogenics, 26, 29, 32
Cybernetics, 25

D

Data acquisition, 2, 21
Data recording, 44
Decontamination, 22
Densitometers, 18
Design, 37, 38
Dictionaries, 17
Digital computers, 14, 34
Display devices, 13, 14, 24
Documentation, 33
Drawings, 44

E

Earth, 1
Earth atmosphere, 14
Earth environment, 42
Earth resources, 7, 31, 43

Earth resources program, 5
 Earth surface, 7
 Earthquakes, 23
 Ecology, 18, 43
 Economics, 32
 Education, 20
 Elastic scattering, 40
 Electric batteries, 14, 43
 Electric conductors, 29
 Electric connectors, 30
 Electric power, 27, 38
 Electric propulsion, 9
 Electric switches, 31
 Electrical faults, 8
 Electrochemical cells, 14
 Electroencephalography, 8
 Electrohydraulic forming, 32
 Electromagnetic hammers, 28
 Electromagnetism, 3
 Electronic equipment, 21, 29
 Electronic modules, 24
 Embedding, 24
 Encapsulating, 24
 Environment models, 42
 Environmental control, 13, 18
 Equipment specifications, 29
 Evaluation, 37, 38
 Explosive forming, 32
 Extraterrestrial environment, 20
 Extraterrestrial life, 2, 16
 Extraterrestrial matter, 12
 Extraterrestrial radiation, 16
 Extraterrestrial resources, 6
 Extravehicular activity, 12, 15

F

Failure analysis, 37
 Falling spheres, 6
 Fibers, 34
 Fire prevention, 18, 29
 Flat conductors, 29
 Flow distribution, 11
 Fluid films, 34
 Fluidics, 30
 Fog, 10
 Form factors, 40
 Forming techniques, 34
 Free vibration, 9
 Frequency measurement, 21
 Fuel cells, 12
 Furnaces, 31

G

Garments, 13
 Gas bearings, 23
 Gemini flights, 7
 Gemini project, 15, 35
 Geometry, 39

Graphs (charts), 44
 Gravity gradient satellites, 18
 Ground stations, 15, 24
 Ground support equipment, 41

H

Handbooks, 24, 29, 30, 39, 41, 42
 Hardware, 37
 Heat-resistant alloys, 11
 Helium, 42
 High temperature, 31
 High temperature gases, 9
 Histories, 35, 36
 Holography, 13
 Horizon scanners, 16
 Human factors engineering, 10, 12, 25
 Human performance, 6, 13, 20, 37
 Human reactions, 8
 Human tolerances, 20
 Hydrodynamics, 34
 Hydrogen, 29
 Hyperoxia, 18
 Hypervelocity impact, 20

I

Imaging techniques, 9
 Indexes (documentation), 33, 43, 44
 Induction heating, 31
 Industries, 27
 Information retrieval, 43, 44
 Infrared radiation, 40
 Inorganic coatings, 30
 Instruments, 28
 Interplanetary flight, 2, 41
 Interplanetary medium, 21
 Interstellar matter, 13

J

Jet aircraft noise, 10
 Jet flow, 10
 Joints (junctions), 24
 Jupiter (planet), 41

L

Lasers, 23
 Layouts, 44
 Leakage, 29, 30
 Lens design, 4
 Life detectors, 16
 Life support systems, 14, 15, 20
 Lithium alloys, 32
 Low temperature environments, 32
 Lubrication, 30, 34
 Lunar bases, 6
 Lunar exploration, 3, 6
 Lunar geology, 4
 Lunar landing sites, 4
 Lunar Orbiter, 4, 14
 Lunar photographs, 17, 20

Lunar rocks, 3
Lunar topography, 3, 4, 14

M

Machine tools, 28
Magnesium alloys, 32
Magnetic coils, 28
Magnetic fields, 8
Magnetic tape recorders, 28
Magnetosphere, 40
Man-machine systems, 13, 18, 25
Management, 36, 38, 43
Management planning, 25, 37, 38
Manipulators, 25
Manned space flight, 5, 13, 18, 23, 35, 36, 38
Manual control, 6
Manuals, 38
Manufacturing, 32
Maraging steels, 31
Mariner space probes, 2
Mars (planet), 2, 39, 41
Mass, 38
Materials, 39
Materials science, 28
Mathematical models, 25
Mathematics, 34
Measuring instruments, 21
Mechanical engineering, 19
Mechanical properties, 32
Membranes, 28
Mercury project, 36
Metal bonding, 30
Metal oxides, 12
Metalworking, 32, 34
Metallurgy, 26, 31
Metals, 32, 34
Meteoroid hazards, 12
Meteoroids, 20
Meteorological parameters, 13
Meteorological satellites, 24
Microbiology, 21
Microelectronics, 31
Micrometeoroids, 12
Mineralogy, 31
Miniature electronic equipment, 28
Mission planning, 9, 37, 39
Monitors, 23
Motion sickness, 6
Multilayer insulation, 28

N

Nacelles, 10
Navigation, 19
Neuromuscular transmission, 6
Nickel steels, 31
Nitrogen, 42
Noise reduction, 10, 11

Nondestructive tests, 27
Numerical analysis, 9
Nutritional requirements, 10

O

OAO (Orbiting Astronomical Observatory), 4
Operations research, 37, 38
Optical communication, 4
Optical correction procedure, 9
Optimal control, 13
Organic compounds, 41
Orifices, 23
OSO-1 (Orbiting Solar Observatory), 16
Oxidation resistance, 30

P

Performance prediction, 9
Permeability, 28
Photographs, 1, 7, 44
Photointerpretation, 3
Physiological factors, 18
Planetary atmospheres, 14, 19
Planetary composition, 2
Planetary landing, 16
Plasma generators, 26
Plasma jet synthesis, 26
Plasma physics, 18
Plasma spraying, 30
Plasmas (physics), 8
Plates (structural members), 9
Portable life support systems, 13
Potential fields, 40
Powder metallurgy, 34
Precipitation hardening, 26
Precision, 28
Predictions, 23
Procurement, 38
Project management, 38
Propulsion system performance, 10

Q

Quality control, 24, 37, 38

R

Radiation measurement, 13, 14
Radiation protection, 16
Radio astronomy, 13
Radio telemetry, 40
Ranger 9 lunar probe, 20
Rare gases, 18
Ray tracing, 40
Reaction kinetics, 9
Recording, 28
Refractory materials, 24
Regeneration (physiology), 14
Regenerative fuel cells, 12

Relay satellites, 15
 Reliability, 37, 38
 Reliability engineering, 22
 Remote handling, 25
 Remote sensors, 5, 43
 Reports, 43, 44
 Research and development, 27
 Research facilities, 36
 Research projects, 20
 Respiratory physiology, 6
 Rocket sounding, 13

S

Satellite-borne photography, 4
 Satellite design, 12, 18
 Satellite instruments, 12
 Satellite observation, 3
 Scattering cross sections, 40
 Scientific satellites, 12
 Seals (stoppers), 26
 Sensory stimulation, 8
 Shock wave propagation, 11
 Simulation, 18
 Skin friction, 42
 Sliding friction, 8
 Solar flux, 16
 Solar physics, 16, 19
 Solar wind, 21
 Soldering, 30
 Solid lubricants, 30
 Sonic booms, 11
 Sounding rockets, 6, 13
 Space capsules, 18
 Space communication, 4
 Space flight, 36
 Space flight feeding, 10
 Space glossaries, 44
 Space laboratories, 20
 Space programs, 3, 36
 Space stations, 5
 Space suits, 12
 Spaceborne photography, 5, 17
 Spaceborne telescopes, 4
 Spacecraft, 34, 38
 Spacecraft components, 8
 Spacecraft control, 19
 Spacecraft design, 19
 Spacecraft guidance, 19
 Spacecraft instruments, 16
 Spacecraft performance, 15
 Spacecraft power supplies, 8, 16, 38
 Spacecraft shielding, 16
 Spacecraft sterilization, 21
 Spectroscopy, 28
 Spheres, 40
 Spot welds, 29
 Sprayed coatings, 26
 Stability, 21

Stabilization, 18
 Stainless steels, 24, 26
 Stellar luminosity, 40
 Structural design, 30
 Subsonic flow, 10
 Supersonic transports, 11
 Surface properties, 41
 Surveyor lunar probes, 4
 Surveyor project, 37
 Systems analysis, 9, 25
 Systems engineering, 37, 38

T

Technical writing, 44
 Technology transfer, 23, 25, 27, 30
 Telecommunication, 19, 40
 Teleoperators, 25
 Temperature measurement, 26
 Tensile strength, 29
 Terminology, 17
 Theorem proving, 8
 Thermal insulation, 28, 30
 Thermocouples, 26
 Thermodynamic equilibrium, 41
 Thermodynamic properties, 14
 Thermodynamics, 41
 Tooling, 28
 Tracking (position), 21
 Traction, 32
 Transport properties, 9
 Trapped particles, 42
 Tungsten, 34
 Turbulent boundary layer, 10
 Typewriters, 44

U

Ultrasonic tests, 27
 Umbilical connectors, 15
 Units of measurement, 44
 University program, 20
 Upper atmosphere, 6

V

V/STOL aircraft, 10
 Vacuum apparatus, 31
 Valves, 30
 Velocity distribution, 42
 Venus (planet), 41
 Vestibular tests, 6

W

Wear, 8
 Welding, 30
 Whiskers (single crystals), 34

X

X-ray inspection, 27

Z

Zodiacal light, 21



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